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9. VERBAL INTERACTION BETWEEN TEACHERS AND STUDENTS IN PRIMARY AND SECONDARY CLASSROOMS

INTRODUCTION

Classroom instruction is a complex cultural activity. Teaching experience and strategies are tacit knowledge, which are always hidden in educational practice. Tacit knowledge, in contrast to explicit knowledge that can be articulated, is difficult to abstract and write into books for wide acceptance. Thus, teaching experience and strategies should be acquired in context (Chen, 2004). In recent years, researchers in the field of education have started using visual case studies to examine problems in the classroom. The interaction analysis on verbal behavior of teachers and students in classrooms (IAVBTSC) is the most representative research method.

The research object of IAVBTSC is the verbal behavior of teachers and students in classrooms. By collecting, systematically analyzing, and processing verbal information, we can study the teaching mode, structure, and interactive level of classroom instruction.

Nearly eight years (2002 to 2010) after the author's research into the interaction analysis of the verbal behavior of teachers and students in primary and secondary classrooms in mainland China, the author has revealed an important finding. Aside from using data or diagram to describe the classroom instructional activities and their modes, the IAVBTSC can also reveal and remedy problems in classroom instruction and improve teachers' instructional and reflective abilities, thus promoting their professional development.

By combining the research cases accumulated over a period of eight years and the software systems designed and developed by the author and her research team, this chapter introduces the application of analytical methods on the verbal behavior of teachers and students, such as the S-T and Flanders Interaction Analysis System, in the analysis of the teaching mode and level of classroom interaction. The chapter also discusses how these analytical tools were used in the practicing community to promote the professional development of teachers.

LITERATURE REVIEW ON CLASSROOM TEACHING BEHAVIORS

Definition of Classroom Teaching Behaviors

Teachers' professional skills can be directly reflected in the classroom. The research focus on teachers' classroom teaching behaviors in China has changed with the thorough development of educational reform since the 1960s. However, the general

E.H.F. Law and C. Li (Eds.), Curriculum Innovations in Changing Societies, 161–188.

trend is from macroscopic to microscopic, extrinsic to intrinsic, group-focused to individual-focused, teacher-focused to student-focused, and quantitative research to a mixture of quantitative and qualitative research.

Prof. Cai maintains that teachers' classroom teaching behaviors, as part of classroom instructional activities, determine instructional quality (Cai & Che, 2008). In terms of classroom instructional practices, when superficial factors such as teachers' instructional methods and approaches have been improved, teachers' classroom teaching behaviors will be improved, driven by less superficial factors such as teaching philosophy, educational beliefs, and instructional ideas. Thus, improving classroom teaching behaviors is key to increasing educational efficiency in class.

Classification of Classroom Teaching Behaviors

According to pattern and function, teachers' classroom teaching behaviors can be classified into major teaching behaviors, supplementary teaching behaviors, and classroom management behaviors. According to form, classroom teaching behaviors are categorized as extrinsic or intrinsic, as shown in Table 1 below.

Table 1. Classification of classroom teaching behaviors (built on Cai & Che, 2008; Zhang, 2004)

Classification	*Criteria*	*Behavior Description*
According to the pattern and function of teachers' classroom teaching behaviors	Major teaching behaviors	Teachers' major behaviors in the class, such as presentation, dialogue, and guidance This kind of behavior is goal – or content-oriented. Effective major teaching behaviors are based on teachers' solid professional knowledge and skills.
	Supplementary teaching behaviors	They are teachers' classroom behaviors, which intend to help major teaching behaviors produce a better teaching effect. They are student – or concrete instructional context-oriented, which include developing and triggering students' motivation, effective communication, and reinforcement skills, as well as teachers' positive expectation.
	Classroom management behaviors	Pertain to a dispensable kind of behavior to ensure the operation of instruction; these behaviors mainly relate to the management of classroom behaviors and the allocation of time. Effective classroom management behaviors are closely related to teachers' classroom experience and professional attainment.
According to the form of classroom teaching behaviors	Extrinsic teaching behaviors	Teachers' and students' visible behaviors, such as verbal or physical behaviors
	Intrinsic teaching behaviors	Thoughts and ideas exist in one's brain to guide the action.

Research on Classroom Teaching Behaviors

Recording method on classroom teaching behaviors. The teaching process is an interaction of teaching and learning, and teaching information is constantly changing, because teachers need to choose specific teaching behaviors according to the specific teaching context in the class. Thus, teachers' classroom teaching behaviors are complex and variable (Cai & Che, 2008). To record and analyze the complex and variable teaching and learning behaviors in the classroom, the use of classroom teaching videos is credited by many researchers as an effective tool for assessing teachers' knowledge (Ball & Cohen, 1999; Little et al., 2003).

Ball and his colleagues used classroom teaching videos to evaluate teachers' classroom behaviors, and how they reflect and represent teachers' knowledge (Ball & Bass, 2000). This research provided us with a new method and perspective to examine classroom teaching behaviors. Ball and his colleagues found possible evidence to determine teachers' knowledge using teaching videos, and created a method for evaluating teachers' knowledge, which is helpful in understanding effective instruction (Hill et al., 2004).

Classroom teaching videos are believed to have become more popular, and have been playing a vital role in teachers' professional development (Kazemi & Franke, 2004; Borko et al., 2008; Borko et al., 2011). They can be used as a tool for gathering the daily experiences of teachers and students, and they can improve teachers' interest in classroom practices, or aid teachers in constructing substantial questions. They can help teachers examine others' instructional strategies and their impact on student learning, which stimulates discussion among teachers and may help teachers collect suggestions on classroom practices. Classroom teaching videos can be used for teachers' professional learning after class, especially for providing a basis for examining and analyzing instructional practices. Moreover, objectively, this kind of tool can help educators build new practical knowledge in teaching (Desjardins, 2001).

Analyzing methods for assessing classroom teaching behaviors. Classroom teaching is an educational activity, with teachers and students serving as dialogue subjects, with verbal communication as the primary means of communication, and individuals' free and conscious development as the ultimate goal (Qiu & Zhang, 2006). Verbal behavior is the main teaching behavior in the classroom, accounting for 80% of all teaching behaviors (Moore, 2000). Thus, to a large extent, verbal behaviors are representative samples of teaching behavior in an entire class (Wang & Liu, 2008). Moreover, the verbal activities of teachers and students are explicit, which facilitate the objective recording for evaluators. In general, two kinds of class dialogues are known: public and personal. Public dialogue is the dialogue everyone in the classroom can hear, whereas personal dialogue is between the teacher and specific students. The analysis of and research on classroom teaching behaviors can be conducted through an in-depth study of the public dialogues in class, to find and discover the teaching and learning principles in the teaching process. By doing this, we can find a way to improve teachers' teaching skills and efficiency, make teaching a more purposeful and conscious activity, motivate teachers to improve their teaching practices, and finally help improve students' scores and their comprehensive development.

Classroom observation method is the main approach used to analyze teachers' teaching behaviors in the classroom. By comprehensively, systematically, and objectively recording teachers' classroom teaching behaviors during the observation, we can conclude the characteristics of effective teaching behaviors. This method focuses on extrinsic teaching behaviors (Cai & Che, 2008). At present, two common analyzing methods on teaching behaviors are used: coding system analysis and semiotic system analysis.

Coding system analysis is an analysis method based on classroom observation, which codes the public dialogues in classroom teaching videos according to cognitive theories, teaches theories and professional curriculum information to externalize intrinsic knowledge, and uses the results to analyze the teaching process. In general, the coding system has two goals: (1) to describe the teaching quality, which is directly related to the curriculum criteria, and (2) to effectively reflect the actual classroom teaching situation. Thus, a coding system codes not only the structure, but also the instruction process.

Semiotic system analysis is similar to the content analysis method. It is an analysis method that lists the possible behaviors to be observed into a semiotic system observation form in advance, and the observer records the frequency of each behavior and analyzes the results.

Both coding system and semiotic system analyses are observation-based qualitative research on the class. Researchers mainly use time or event sampling to disassemble the structure of a class into categories and factors, which will be used to develop an observation tool for collecting factual qualitative resources for value judgment (Gao, 2007). Through further statistical analysis and qualitative treatment, we can draw a conclusion regarding the characteristics of teaching behaviors and the relations between factors of an instruction, discover the teaching and learning principles in the teaching process, and provide various information and evidence for teachers' reflection and improvement of teaching practices. Classroom teaching behavior analysis as a performance evaluation method can focus more on teachers' classroom teaching practices, and support both researchers and teachers to reflect the teachers' classroom teaching behaviors, which will promote deep communication between them.

Observation method is the main research technique for evaluating teachers' teaching behaviors in the classroom. This method focuses on the teachers' external teaching behaviors. By comprehensively, systematically, and objectively recording teachers' classroom teaching behaviors during the observation, we can conclude the characteristics of effective teaching behaviors. With the development of research in this field, the use of the questionnaire method, inductive method, and lecture method has started. However, these methods lack objectivity, validity, credibility, or empirical evidence. Further research on teachers' teaching behaviors can be based on critical theory, learning theories, and cultural anthropology to strengthen the theoretical basis of the research. On the other hand, researchers should focus more on the teaching practices in the classroom, and study and reflect on them with the teachers. Research methods are suggested, such as action methodology, ethnographic method, and deep description.

CLASSROOM TEACHING MODEL ANALYSIS METHOD

Teaching method is a tied relationship among teacher-student relationship, content, and process, and it includes their structures. These three structures are interrelated and constitute an entire instructional structure (Huang & Wang, 1995).

Until now, research on various models has contributed to the form of "model methodology." Model theory, an important branch of modern scientific methodologies, has become a critical research method. A major characteristic of model methodology is its focus on an object's essential or special parts other than the unessential or normal ones. Model methodology highlights an object's major factors, relations, status, and process, which facilitate people to investigate, simulate, measure, and conduct experiments or theoretical analyses. From the perspective of model methodology, quantitative modeling and qualitative modeling are the two types. Qualitative modeling has been used in most research, especially on instructional modeling.

The classroom instructional model analysis method discussed in this chapter is a combination of quantitative and qualitative modeling, which is based on the collection, analysis, and processing of classroom information. This method requires researchers to (1) observe classroom instructional activities; (2) record all activities during the whole period using certain recording skills such as videotaping skills; (3) code and collect data of a video using a specific time gap; and (4) process data and decide whether the class instructional mode will be categorized as lecture, practice, dialogue, or blended model. (Fu & Zhang, 2001).

Case 1: Using the S-T Analysis Method to Analyze Four Types of Instructional Models

Background introduction of this case L is a high school math teacher in Beijing, with 10 years of teaching experience and is at the professional maturity stage. As a math teacher, L thinks that knowledge and skills gained through recreation is easier to comprehend and retain than those acquired passively; thus, math instruction should be a procedural instruction of mathematical activities. Information technology environment firmly supports students' effective recreation within a limited class period. The math instructional model should include a relatively stable instructional process and operational instructional activities in which a teacher, aided by academic concepts, instructional theories, and learning theories, guides students to gain

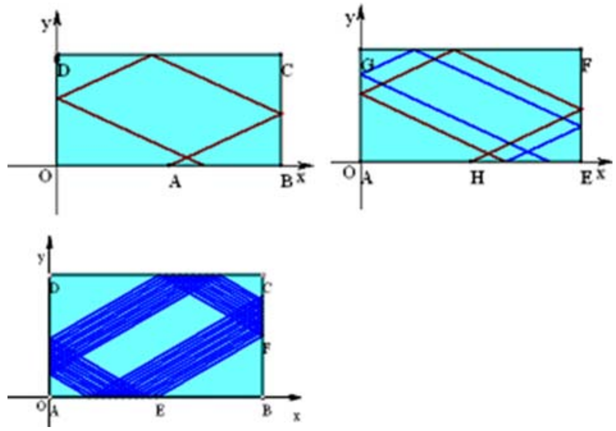

Figure 1. Key images used in the PowerPoint presentation. A. One-round reflection B. Two-round reflection C. Multiple-round reflection.

knowledge and skills by recreating, and achieves specific mathematical instructional objectives in an information technology environment.

Applying this teaching concept, after years of practice and exploration, teacher L has developed a unique instructional model. We will first introduce a Math course on the billiard table, which was designed and taught by teacher L based on a math learning software, Z + Z. The instructional design of this course is shown in Table 2.

[Appendix 1] Key images used in the PowerPoint presentation.

[Appendix 2] 2003 National College Entrance Examination.

Suppose four points of a rectangle are A (0,0), B (2,0), C (2,1), and D (0,1). A ball sets off from the middle point of side AB, Po. The angle between its direction and side AB is Θ. The ball was reflected by sides CD, DA, and AB on points P2, P3, and P4, respectively (angle of incidence = angle of reflection). Suppose P4 (X4, 0), and 1 < X4 < 2. What is the value range of tg?

$$\text{A. } \left(\frac{1}{3}, 1\right) \quad \text{B. } \left(\frac{1}{3}, \frac{2}{3}\right) \quad \text{C. } \left(\frac{2}{5}, \frac{1}{2}\right) \quad \text{D. } \left(\frac{2}{5}, \frac{2}{3}\right)$$

Teacher's reflection after class: In this class, the computer as a pure instructional tool can be used flexibly, which makes computer-assisted instruction more natural and relative. During the instructional activities, students are subjects of understanding. Subjectivity is the core and soul of modern math instruction. Being active is the specific representation of subjectivity, and a core composition of a new instructional model. In this course, the teacher always creates scenarios with questions, and students can continue testing their conjectures by PowerPoint visualization to solve problems. This process focuses on the students' subjectivity and their re-creation of questions, which effectively promote students to further

Table 2. Instructional design of Math on the billiard table

Module	*Teacher's Guide*	*Students' Learning*	*Activity Objective*
Create a scenario and motivate students to engage themselves in the activities.	Scenario: For a billiard board with length: width = 2:1, if a ball sets out from the middle of a length (point A), and will be reflected by the three other sides once, respectively, on what condition will it return to point B? Prepare a PowerPoint presentation to help visualize the scenario.	Use what students have learned to explore, guess, and solve the problem.	Create a problem scenario and motivate student curiosity.
Explore and conduct a group discussion	Join students' discussion. Focus on the group that has a problem with conducting discussions, and provide appropriate guides, with emphasis on the evaluation of students' thinking characteristics reflected in their methods for solving the problem.	Prioritize independent thinking, followed by group discussion. Determine points for critical thinking: analytic geometry, building coordinate system, gradient, and symmetry.	Combine independent thinking and group study.
Cooperate and communicate. Solve the problem.	Students and the teacher evaluate together the abstract subject matter and solutions.	Every group presents its representative solution, and other groups evaluate it. [Conclusion] When k = 2/5, the ball will be back to point B.	Communicate between groups. Students and the teacher make an evaluation together.
Construct new knowledge. Analyze the problem.	1. Derivation: If a ball sets out from the middle of a length (point A), and is reflected by three other sides once, respectively, on what condition will it return to side AB (the entire side)? Prepare a PowerPoint presentation, which facilitates students to find the law directly. (Refer to Appendix 1.) Encourage students to ask questions. What other questions can they come up with?	Explore the solution. You can consider extreme values or regular points. Conclusion: k is between 2/5 and 2/3.	Students explore independently, and communicate with each other.
	2. Second derivation: If the ball can be reflected again, what are its coordinates when it returns to side AB? Prepare a PowerPoint presentation, which facilitates students to find the law directly. (Refer to Appendix 1.)	Ask the question: Into what range will the ball fall? This is to be answered by other groups.	Present a new question, which promotes the integration and application of new knowledge.

(*Continued*)

Table 2. Instructional design of Math on the billiard table (Continued)

Module	*Teacher's Guide*	*Students' Learning*	*Activity Objective*
	3. Continue exploring: If the ball continues to be reflected, what are its coordinates when it returns to side AB the third time? What about the fourth time? Can you form a certain rule/law summarizing this behavior? (Refer to Appendix 1) Suppose that after one reflection, the ball returns to point A_1 on side AB, point A_2 after two reflections, and so on, determine the law that relates $A_1, A_2, \ldots, A_n$.	Suppose after one reflection, the ball returns to point A_1 on side AB, point A_2 after two reflections, and so on. Determine the law that relates $A_1, A_2, \ldots, A_n$. Students may use different methods to study. Some may attempt to determine the law by several calculations; others may assume a normal point at the start.	Determine the dialectical relationship between normality and specialty.
Cooperate during the exploration. Form conclusions.	Lead, help, and explore together. Provide timely and effective help to the team having difficulty with the research.	Discover the rule, and test the assumption. Evaluate the result : x-coordinates are in an arithmetic sequence. Analyze the result.	Help students develop themselves.
Explore independently. Develop innovative skills.	What other questions do you have? Show the PowerPoint presentation. Give students a chance to observe further the reflection rule. Motivate students to think and speak freely, without consideration of whether their conclusions are correct or not.	Think and speak freely. Contribute valuable ideas.	Promote divergent thinking. Develop students' abilities to formulate insightful questions.
Reflect and conclude.	Conclude on the knowledge and methods used in this course, and write a short essay about the billiards question. Everyone should choose a topic based on the questions explored in class, and write a short essay on it. Deadline: A week later.	Expand what the students have learned after class. Continue the research.	Develop a new learning method. Encourage students to explore science.

understand the developmental process of math content knowledge.According to modern educational theories, most students' knowledge is not acquired from teachers. Instead, such knowledge is meaningfully constructed under a certain condition with the help of others using necessary learning materials, which is in line with Socrates' idea of birth-assistantship. Famous math educators Karl Weierstrass and George Polya have successfully applied this idea in math education. Polya's idea is that teachers should provide students with "appropriate" help. The instructional design of this course reflects this rule: Students should discover and improve themselves through various discovery activities, such as observing, analyzing, analogizing, conjecturing, and summarizing, to develop their expansive thinking and creative skills. The educational idea that modern information technology and math instruction should be integrated is popular. Information technology-assisted instruction has been widely used as a new educational model. However, technology is an insufficient solution. We cannot merely focus on the animation and sound functions of computers without understanding the nature of mathematics. When we integrate information technology with a traditional instructional model, traditional pen-and-paper operation, deduction, drawing, and the application of information technology should be balanced. At times, students cannot use computers to solve problems. This phenomenon represents a kind of frustration, which makes students appreciate the importance of mathematical logic, and thus, improve their own math literacy.

Research Topic

We conducted the instructional model research on teacher L's class, Math on the billiard table.

Introduction on the S-T Analysis Method

Principal idea. The S-T analysis method, which is used to analyze instruction, can present instructional mood directly. It can also analyze and evaluate an instructional process qualitatively and quantitatively, to define the instructional mood and gain uniform and objective information (Fu & Zhang, 2001). In the S-T analysis method, only teacher's activities (T) and students' activities (S) are included, which can reduce the ambiguity of the classified narration of instructional activities and improve its objectivity and reliability, and thus are beneficial for teachers to gradually comprehend and improve teaching, and promote their professional development using this method.

Definition of activity types. Activity T is defined as teachers' visual and audio information transition activity, and other activities are classified as S. In a normal instructional process, activity T mainly includes teacher's speaking (audio) and blackboard writing or presentation (visual). These activities include explanation,

S − T Data Record Card No:

School	X junior high school
Teacher	Teacher A
Date	2/4/2002
Subject	Math (Junior 2nd grade)
Textbook	*Definition and characteristics of rhombus*
Sampling Gap	15 s

	0	1	2	3	4	5	6	7	8	9
0	T	T	T	T	T	T	T	T	T	T
1	T	T	T	T	S	T	S	S	S	S
2	T	T	S	T	T	T	S	T	T	T
3	T	T	T	T	S	S	T	S	S	T
4	T	T	T	T						
5										

Note: The case lasted for 11 minutes, and included 44 data.

Figure 2. S-T data record card.

presentation, blackboard writing, multimedia-based presentation, inquiring, calling the roll, as well as evaluation and feedback.

Activity S includes all activities except activity T, mostly consisting of students' thinking, speaking, calculating, note taking, conducting experiments, completing assignments, and monitoring order in class.

Data collection method. This method is carried out by sampling and coding a class (by observation or video) with a specific time gap, recording the result on an S-T record card, after which an S-T data sequence (or an S-T data for short) can be obtained

If the S-T data are created manually, the observation results may be added to an S-T data record card, as shown in Figure 2.

Analysis of instructional model. We can present the instructional model in two ways. One is through the S-T diagram, which shows the changes in activity S and activity T through time. Another way is through the Rt-Ch diagram, which shows a class' instructional model, especially its instructional mood and type.

Diagram S-T should be drawn on a separate drawing sheet. In general, a coordinate paper is used. The vertical axis S and the horizontal axis T present the time that activity S and activity T occurred, respectively. The origin is the start of a class. The observed data of activity S and activity T until class dismissal are displayed on axes S and T, as shown in Figure 3.

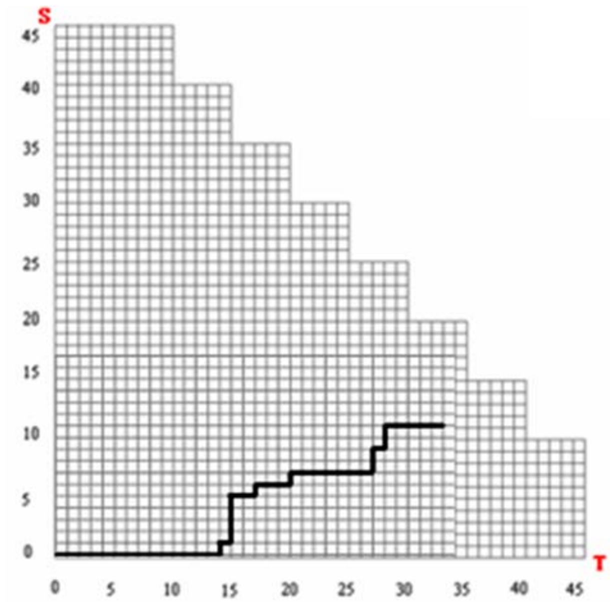

Figure 3. S-T diagram.

In Figure 3, Rt and Ch are defined as the rate of activity T and the frequency of activity-switching, respectively, which are important in describing the instructional model and analyzing the instructional process.

Rt = NT/N. N is the total number of sampled activities, and NT is the total number of T activities. Rt ranges from 0 to 1. The larger the Rt, the larger is the ratio of activity T to all sampled activities, which indicates a larger ratio of teacher's activity in the entire instructional process.

Ch = (g-1)/N. N is the total of sampled activities. g is defined as the number of times a continuous sequence of the same activity occurs. For example, suppose a sampled S-T data sequence is TTSSTSSTTT, then five continuous sequences are present: TT, SS, T, SS, and TTT, and g = 5.

The Rt–Ch diagram is a two-dimensional diagram with the horizontal axis Rt and the vertical axis Ch, as shown in Figure 4.

A class can be located in the Rt-Ch diagram. The shaded area in Figure 4 is the logic range of point (Rt, Ch). In the Rt-Ch diagram, Rt and Ch are defined as the rate of activity T and the number of times of activity-switching, respectively. Thus, they can be used to distinguish four kinds of instructional models: a practical instructional model is student-centered, and has a low rate of student-teacher activity-switching; a lecture model is teacher-centered, and has a low rate of student-teacher activity-switching; a dialogue model has a balanced teacher-student ratio and a high rate of student-teacher activity-switching; and a blended model has a balanced teacher-student ratio and a low rate of student-teacher activity-switching. Figure 3 displays

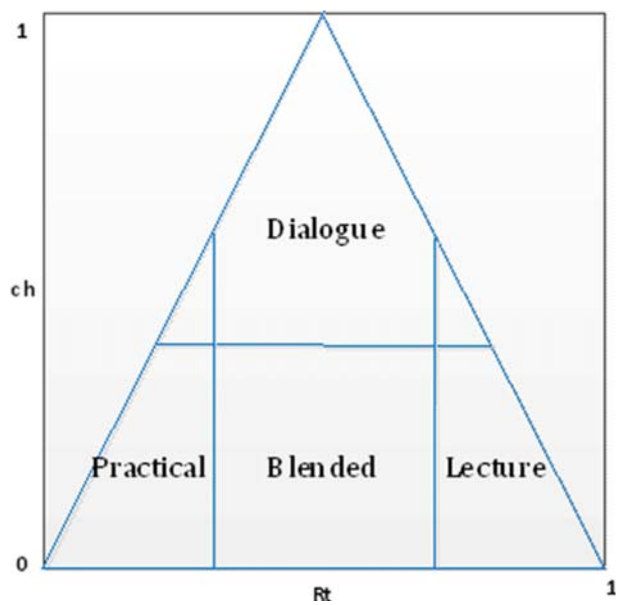

Figure 4. Rt-Ch diagram.

an instructional process, which lasted 50 minutes, and was sampled for 30 seconds. Rt and Ch are used to distinguish instructional models.

The Rt-Ch diagram can distinguish four types of instructional models effectively. Thus, the diagram can also describe the instructional mood. In addition to defining the instructional model of a class, the Rt-Ch diagram can compare the instructional models of various instructions. For example, the diagram can be used to compare a class to a teacher's former class, and compare the instructional model of an intern teacher's class to that of an experienced teacher's. Thus, the Rt-Ch diagram can be employed to conduct various research studies on instructional models.

Research process and method

Based on the introduction above, the S-T analysis method can be inferred to consider only the T and S, which reduces the ambiguity of the activity classification of instructional activities and improves its objectivity. This visualized method presenting an instructional process by figures requires no complex calculation. Thus, this method can be easily promoted and applied in instructional research. Nevertheless, conducting S-T analysis (for example, drawing S-T and Rt-Ch diagrams manually) is time – and labor-consuming. Thus, our research team has developed an S-T analysis software in C language, as shown in Figure 5, to reduce the researcher's burden and increase research accuracy. Using this software only

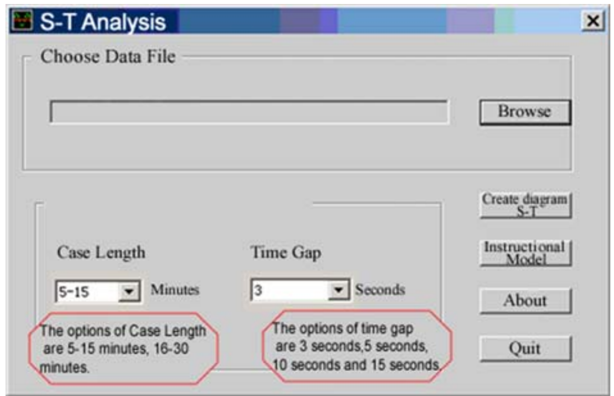

Figure 5. A window from the S-T analysis software.

Table 3. Instructional models and their standard conditions

Instructional models	*Standard conditions*
Practical	$Rt \leq 0.3$
Lecture	$Rt \geq 0.7$
Dialogue	$Ch \geq 0.4$
Blended	$0.3 < Rt < 0.7$, $Ch < 0.4$

requires the researcher to perform the sampling and add the S-T sequence to a specific Excel form, after which, the software can complete the work on its own.

The method for using the S-T analysis software is as follows:

– *Step 1: Data collection.* The time gap of sampling depends on the length of a class. In Table 3, the cut-offs of the four instructional models are for a class that lasts 50 minutes, with a sampling time gap of 30 seconds. We recommend the sampling time gap of 30 seconds for a 45-minute class. For a 15-minute class, we recommend 10 seconds, whereas for a less than 15-minute class, we recommend 5 seconds. From the statistics perspective, the shorter the sampling time gap, the more samples represent the entire condition. However, if the sampling time gap is extremely short, sampling becomes increasingly difficult. Thus, the sampling time gap should be no longer than three seconds.

  In most cases when researchers watch videos, videos can be temporarily stopped for the manual or automatic sampling time gap. For example, if we select the sampling time gap as five seconds, the video will be paused on the fifth, tenth, and fifteenth seconds, which will define if the activity is for the teacher or for the student. We can then enter the data in an Excel form, as shown as Figure 6. This process repeats until an entire S-T sequence has been formed.

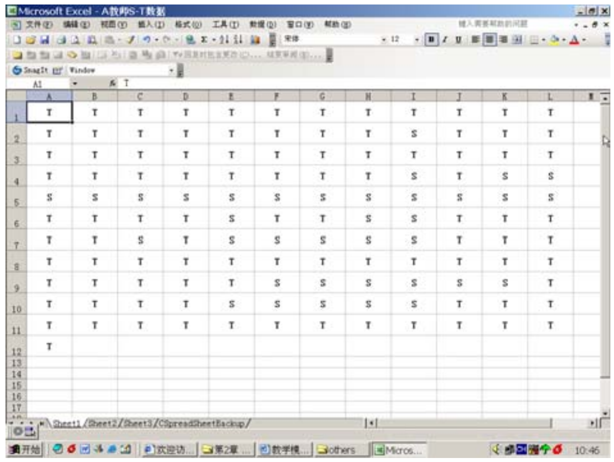

Figure 6. S-T data file in Excel.

For the data analysis conducted by the S-T analysis software by reading an Excel file, an S-T sequence is entered in Excel to process the operation. To enter and check the data easily, we typically use an entire row to record all the data within one minute. For example, in Figure 6, the first row includes all the data collected during the first minute. Considering that the sampling time gap of the case in Figure 6 is 5 seconds, 12 kinds of data can be collected within one minute.

– *Step 2: S-T analysis.* Click the "Browse" button in Figure 5, and then choose the data file for the S-T analysis. A window will subsequently appear, as shown in Figure 7. Click the pop-up menus for "Case Length" and "Time Gap," and select case length and time gap, respectively. For example, in the class on Math on the billiard table, its length is 45 minutes, and we select "31–45 minutes" and "10 s."

If you click the "Create diagram S-T" button, as shown in Figure 7, a pop-up named "Diagram S-T" appears. When you select "Create" on the right upper side, a diagram such as Figure 8 will pop up. Aside from drawing S-T diagrams, the software can also list some basic information of the case on the right, such as length, sampling time gap, and number of S and T activities. Researchers can use a professional screenshot software, such as "SnagIt," to capture and save the picture for further use.

After capturing the screen, you can click "Exit" button to return to the window shown in Figure 7. If you click "Instructional Model," a new window named "Instructional Model Analysis" will appear, and by clicking "Show" at the bottom of the window, a picture like Figure 9 will pop up.

The class on Math on the billiard table is illustrated in Figure 9. On the right side of the figure, the S-T analysis software automatically lists the rate of switching (Ch), rate of activity T (Rt), rate of activity S (Rs) and instructional

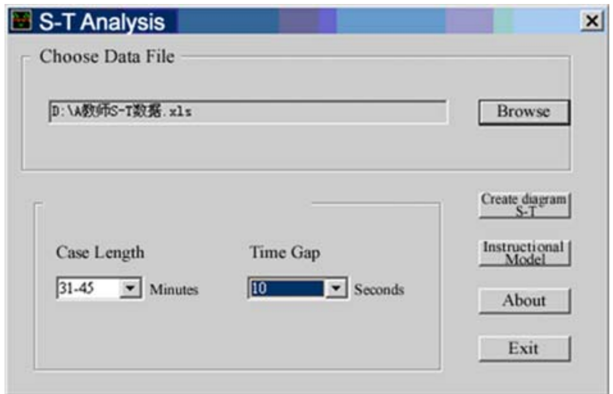

Figure 7. A window from the S-T analysis software for the analysis of Math on the billiard table.

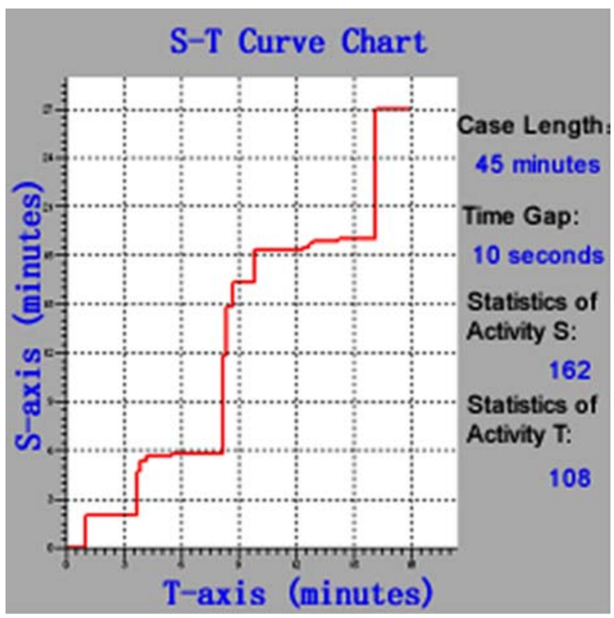

Figure 8. S-T diagram.

model. The class has 40% Rt, 60% Rs, and 10% Ch, which means that the class has a blended instructional model.

– *Step 3: Analysis of the results.* After the S-T analysis on the class on Math on the billiard table, as concluded by Wang (2004), four durations for student activities (four vertical lines) are evident, which means that the teacher has given

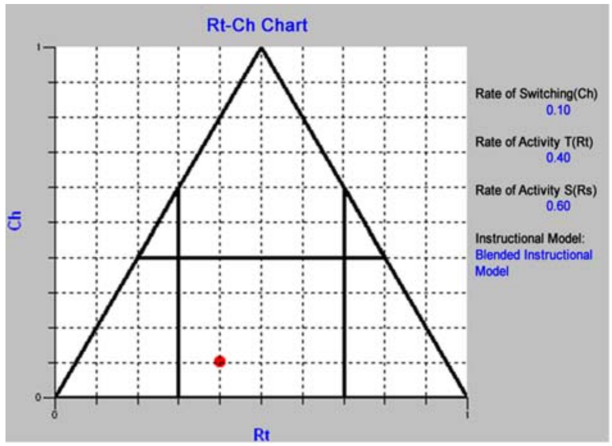

Figure 9. St-Ch diagram.

students enough room to participate in activities and think independently. The rate of students' activities is 60%, which reflects that the teacher has dropped the instructional model "pouring all through a class," and achieved the instructional goal of creating a student-centered class. Moreover, although the rate of student activity is 60%, the rate of activity switching is only 10%, indicating that the activity-switching between the teacher and the students seldom takes place during the four outstanding durations of the student activity. Therefore, when students conduct the activities, the teacher gives them little guidance.

Case Review

The S-T analysis method is easy to use, and has visual as well as objective results. The method is especially convenient for teachers to introduce reflections after class. However, given that the S-T analysis method only classifies instructional activities into teacher or student activity, the information obtained is very vague, and researchers have no idea on the actual meanings of both the teacher activity and the student activity. Thus, the S-T analysis method is only better used to distinguish the four kinds of instructional models, and get an overview of the instructional process. If more precise and diagnostic analysis results are desired, combining the S-T analysis method with other methods may be necessary.

ANALYSIS METHOD ON THE QUALITY OF CLASSROOM INTERACTION

Classroom interaction is a process in which relatively independent individuals help improve each other during an instructional process, and the teacher and the students can exchange their thoughts and feelings, deliver information, and ultimately influence each other. Nowadays, the idea of classroom interaction is deeply rooted in the minds of many teachers who apply it in practice. However, low interaction quality is still a problem, such as monotonous interaction form, numerous interactions between the teacher and a group of students, very few interactions between the teacher and a single student, numerous interactions between a student and a group of students, very few interactions between students, numerous low-level interactions, very few high-level interactions, and so on. Although classes have become increasingly alive since teachers emphasized classroom interaction, the interaction quality has not been improved (Wang, 2005). Thus, logical and scientific evaluation on the quality of classroom interaction has become a key topic in the field of educational research.

Evaluating the quality of classroom interaction requires a scientific method and meticulous classroom observation. With the rapid development of information technologies, recording technologies such as audio and video recording technologies have immensely improved. This chapter introduces a method for analyzing the quality of classroom interaction, which is based on classroom observation and video recording, and focuses on verbal communication between the teacher and the students.

Case 2: Flanders Interaction Analysis Method

Background introduction of this case. In 2003, District A of Beijing had a district-level instructional design competition. This event intended to promote the instructional design skills of teachers. The attending works should have high-quality classroom interactions supported by information technologies. By improving the quality of classroom interaction, the class will become more enjoyable, have effective instructional methods, can motivate students to learn, and improve the self-learning abilities of students.

Thus, the committee of this competition invited the author's research group to conduct the classroom interaction quality analysis on instructional plans as well as the use of classroom videos, which went through the first round of evaluations. Our group should identify problems and solutions for specific cases. Thus, we adopted the Flanders interaction analysis method to analyze the classroom videos.

Research topic. By analyzing the instructional plans and classroom videos provided by the competition committee, our group can identify problems and solutions for the attending works.

Introduction on the Flanders Interaction Analysis System (FIAS) For the quantitative analysis of classroom activities, a mature analysis method was proposed by American scholar Ned Flanders in 1970, which was called the Flanders Interaction Analysis System (FIAS). According to Flanders, recording everything that occurs in the classroom is impossible and unnecessary for researchers. Researchers should be selective regarding the aspects to observe. Considering that most instructional activities are verbal, which account for around 80% of all activities, they can largely represent or define the instructional activities of an entire class. Moreover, verbal activities are explicit and easy for evaluators to record. Thus, FIAS focuses on the verbal activities of the teacher and students.

How to Use FIAS? The elements of FIAS include the dialogues of the teacher and students in a class. This method records verbal interactions between the teacher and the students using a coding system and specifically analyzes them. FIAS has three steps: (1) a coding system to describe the interaction activities in a class, (2) a set of criteria about observation and code recoding, and (3) a matrix form for displaying data, analyzing, and realizing research goals.

– Coding system FIAS classifies verbal activities in a class into three categories and 10 subcategories, as shown in Table 4. Categories one to seven are for teachers talking to their students, whereas categories eight and nine are for students talking to their teachers. Category 10 is for silence or confusion.
– Criteria for observing and recording codes

FIAS requires researchers to do the sampling every three seconds, and formulate the code for a specific period by referring to the coding system. Thus, for a normal 45-minute class, around 900 codes are generated. These symbols represent a series

Table 4. FIAS coding system

Categories		*Teacher/Student/Other Behaviors Observed*	*Code*
Teacher Talk	Indirect Influence	1. Expresses feeling: Accepting and clarifying the feeling tone of students in a nonthreatening manner	1
		2. Praises or encourages: Praising or encouraging students to engage in proper action or behavior	2
		3. Accepts or uses ideas: Clarifying, building, or developing ideas suggested by a student	3
		4. Asks questions: Asking a question about content or procedure for the student to answer	4
	Direct Influence	5. Lectures: Giving facts or opinions about content or procedures; expressing the teacher's own ideas and asking rhetorical questions	5
		6. Gives directions: Providing directions, commands, or orders with which a student is expected to comply	6
		7. Criticizes or justifies authority: Making statements that intend to change the unacceptable behavior of the student and make it acceptable	7
Student discourse		8. Responds: Students talking in response to the teacher	8
		9. Initiates: Students initiating communication or response	9
Invalid		10. Silence or confusion: Pauses, short periods of silence, and periods of confusion that cannot be understood by the observer	10

of events chronologically occurring in a class. These events are lined up as a timeline, which provides highly accurate information about the class. Researchers consequently achieve a highly accurate evaluation of the instructional structure, the activity mode, and the interaction quality of the class by analyzing these codes.

Analysis matrix. After collecting the coded data, FIAS requires researchers to create an analysis matrix based on the obtained data. This matrix is symmetrical in most cases. The rows and columns in the matrix represent 10 activities previously defined in the coding system. When creating the analysis matrix, researchers should combine every two pieces of data next to each other as a coordinate. The first data serve as the row number, the second one as the column number, and the corresponding cell in the matrix is added with 1. For example, the sequence 4, 5, 6, 2, 3, 6, and 9 is combined as coordinates, namely, 4-5, 5-6, 6-2, 2-3, 3-6, and 6-9. Coordinate 4-5 represents the matrix cell in row 4 and column 5 is added with 1, coordinate 5-6 represents the matrix cell in row 5 and column 6 is added with 1, and so on. Researchers ultimately acquire the analysis matrix for the entire class, which is shown in Figure 10.

By calculating the ratio of teacher talk and student discourse, researchers can describe how the ratios of teacher talk and student discourse change, as well as the diagnosis prescriptions.

We can calculate the number of occurrences of each verbal activity and the ratio and structure of each verbal activity among all other activities. These occurrences are measured as Teacher Talk Percentage, Student Discourse Percentage, Ratio of Teacher Indirect and Direct Talk, Ratio of Student Inactive and Active Discourse, the Ratio of Positive Reinforcement (categories 1 to 3), and Negative Reinforcement

		Teacher Talk							*Student Discourse*		*Invalid*	
		(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*SUM*
Teacher Talk	(1)	2	0	0	2	0	1	0	1	0	0	6
	(2)	0	0	0	3	1	4	0	0	0	1	9
	(3)	0	1	3	7	3	1	0	3	0	0	18
	(4)	1	2	0	64	12	16	0	42	8	6	151
	(5)	0	1	0	17	69	12	0	0	0	0	99
	(6)	1	1	1	18	9	54	0	14	11	6	115
	(7)	0	0	0	0	0	0	0	0	0	0	0
Student Discourse	(8)	0	2	13	29	3	14	0	92	0	1	154
	(9)	0	1	0	8	0	10	0	0	278	1	298
Invalid	(10)	2	1	1	3	2	3	0	2	1	36	51
	SUM	6	9	18	151	99	115	0	154	298	51	901

Figure 10. FIAS matrix.

(categories 6 and 7). The data show that: (1) the general structure and characteristics of a class, (2) the power, atmosphere of a class, and students' degree of participation, (3) teacher-centered or student-centered teaching style of a class, (4) deductive or inductive class, (5) restrictive or free students, (6) dull or active class, and (7) students who are active or passive to learning.

Aside from getting the general information of each category, we can also obtain the detailed information about the activities in specific categories. For example, the matrix cell (5-5) represents the continuous talking of the teacher, whereas (8-8) + (9-9) represents continuous discourse of the students. Reclassifying these special activities can provide totally new information. For example, the intersection areas of rows 1 to 3 and columns 1 to 3 reflect if the teacher and students are getting along well with each other, and the degree of active integration of the class.

The FIAS matrix reports not only the quality of the classroom interaction, but also the flow chart of a class. Therefore, after assessing the quality of classroom interaction, as shown in Figure 11, a recommendation can be given.

To use FIAS to diagnose the interaction quality of a class, the biggest number A in row 3 or 4 is first identified, followed by the second biggest number B in that row, the biggest number C in column B, and then the second biggest number D in row C. Finally, the biggest or the second biggest number in row D is checked if it is A or not. If the rectangle ABCD (if it can be one) falls into the rectangle formed by (4-4), (4-8), (8-8), and (8-4), the class has a drill pattern, in which the teacher-student interaction flow is formed by "teacher asks-students answer-teacher asks again." If the rectangle ABCD (if it can be one) falls into the rectangle formed by (3-3), (3-9), (9-9), and (9-3),

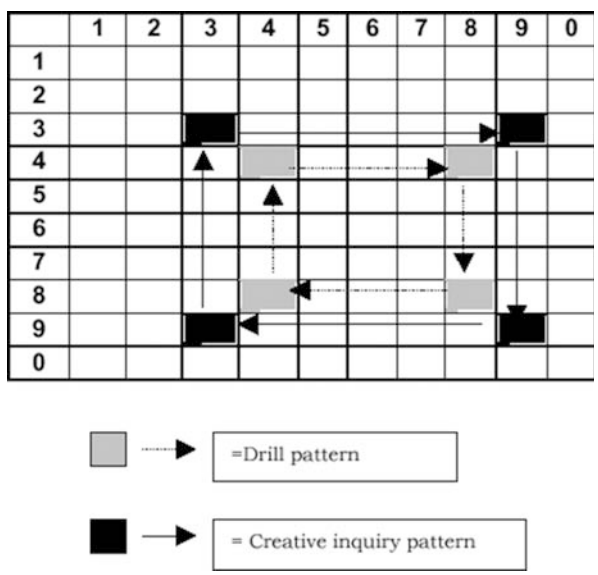

Figure 11. FIAS flow chart.

the class has a creative inquiry pattern, in which the teacher-student interaction flow is formed by "teacher accepts students' ideas and develops the curriculum-students actively express their ideas-teacher accepts students' ideas again." Through this method, we can deeply examine and analyze the quality of teacher-student interaction.

In addition to analyzing the matrix, we can describe how the rates of teacher talk and student discourse change, and how the interactions in a class evolve. By referring to the changing rates of teacher talk and student discourse, we can have a general idea of how teacher-student interaction changes.

The advantages of using FIAS to diagnose classroom interaction quality are as follows:

- FIAS categories reflect the interaction between the teacher and students, and give an operational definition for each kind of verbal activity, which is easier for observers to recognize and categorize in a class.
- FIAS uses a "code" to record the events occurring in a class as well as the time frame. These codes can generally reflect the characteristics of a class, which prepares a solid basis for later evaluation, thereby overcoming the subjectivity of traditional classroom evaluation method and improving the objectivity and scientific nature of the evaluation method.
- Regarding the data processing method, FIAS translates complex classroom events into simple math problems using the analysis matrix and diagram to achieve certain mathematical conclusions. Subsequently, mathematical conclusions can be translated into instructional conclusions that can reflect instructional problems and help us find ways to improve them. FIAS proves to be a very useful diagnosis method.

FIAS, on the other hand, has the following limitations:

- FIAS only reflects the verbal activities in a class and ignores many other important factors, thus affecting the quality of classroom instruction such as body language, instructional content, and board writing. FIAS ignores highly useful information; hence, the evaluation conclusion will not be comprehensive.
- FIAS focuses on the activities of the teacher (total of seven categories) in a classroom instruction, but ignores activities of the students (total of two categories), thus creating difficulty for researchers in comprehensively learning about the student activities.
- As an important part of classroom instruction, information technology should frequently interact with the teacher and the students. However, FIAS cannot reflect this kind of interaction.
- FIAS has high requirements for evaluators. Evaluators must not only remember the operational definition and code of each verbal activity, but also possess excellent ability to identify and be sensitive to time issues.

Enhancement of FIAS Revision of FIAS

With the development of the new curriculum reform of basic education, many schools have equipped their classrooms with information technology. Teachers hope to use electronic materials and technologies to support the learning of learners and improve instructional quality and educational interest. In an information technology-supported classroom, the normal scenes involve "teachers using multimedia technologies such as computer to create various scenarios" and "students using various materials in the computer laboratory to explore by themselves." In these scenarios, no verbal interaction occurs between the teacher and students. Thus, FIAS cannot be used to analyze these classes. For this reason, FIAS has been continuously revised and improved over the years. In 2003, Xinli Zhou proposed to add the 11th code, media (application activity of the information technology tool) to the coding system in her master's degree dissertation. In 2004, Xiaoqing Gu and Wei Wang proposed a new coding system based on FIAS called Information Technology-based Interaction Analysis System (ITIAS), which is shown in Table 5.

– Improved Data Processing Method
  Gu (2000) from the Shanghai Institute for Educational Research interpreted FIAS from another angle, which is shown in Table 6. He used the frequency statistics method to determine the dominant method of instruction.

Table 5. Information Technology-based Interaction Analysis System (ITIAS)

Categories		*Code*	*Reference*
Teacher Talk	Indirect Influence	1	Accepting the feelings of students
		2	Giving praise or encouragement to students
		3	Accepts ideas from students
		4	Asking an opening question
	Direct Influence	5	Asking a closed question
		6	Lectures
		7	Giving directions
		8	Criticizing
Student Discourse		9	Responding passively
		10	Responding actively
		11	Actively asking questions
		12	Discussing with partners
Silence		13	Having confusion unrelated with instruction
		14	Thinking
		15	Taking exercises
Technology		16	Teacher applying technology
		17	Students applying technology
		18	Technology for students

Through the revised FIAS presented in Figure 6, researchers can collect the data every three seconds, and calculate the frequencies of each code. Afterward, the frequencies and rates of "teacher dominates" (code 5–8), "students dominate" (code 1–3, 9), and "neutral" (code 4, 10) can be obtained. As a result, the conclusion about the dominant actor during the instruction is achieved. Table 7 provides an example.

Table 7 verifies that:

– Teacher-dominated instruction is prevalent
– If the class instruction is teacher-dominated (code 5, 6, 7), students will be forced to give a rapid and timely reply to the teacher (code 8). However, this kind of interaction has a certain form, which limits the answers of students.
– Student-dominated instruction is rare (code 1, 2, 3, accounting for 4.3%), which means that students are currently restricted in thinking independently, and teachers do not allow students to express their ideas (code 9, accounting for 0%).

Research Process and Method According to the introduction on FIAS, although FIAS can objectively evaluate verbal actions in a classroom, the short sampling gap (three seconds), various verbal action categories, and complex data processing

Table 6. Alternative interpretation of FIAS

Category	*Code*	*Teacher/Student/Other Behaviors Observed*
	Responses	1. Accepts students' feelings
		2. Praises students' actions
Teacher Talk		3. Accepts students' ideas
	Neutral	4. Asks students questions
	Initiates	5. Lectures
		6. Instructs or commands
		7. Criticizes or justifies authority
Student discourse	Responses	8. Answers teacher's question, or responds to the teacher
	Initiates	9. Students initiate the response, or ask the teacher questions
Silence	Neutral	10. Pauses, short periods of silence, and periods of confusion, which cannot be understood by the observer

Table 7. Frequency statistics of verbal interaction (Total observation duration: 682)

Item	*Student-dominated Instruction*				*Neutral*		*Teacher-dominated Instruction*			
Code	1,2	3	9	Total	10	4	8	5	6,7	Total
Frequency	10	19	0	29	48	189	216	145	55	416
Percentage	1.5	2.8	0	4.3	34.8		31.712	21.3	8.1	61.0

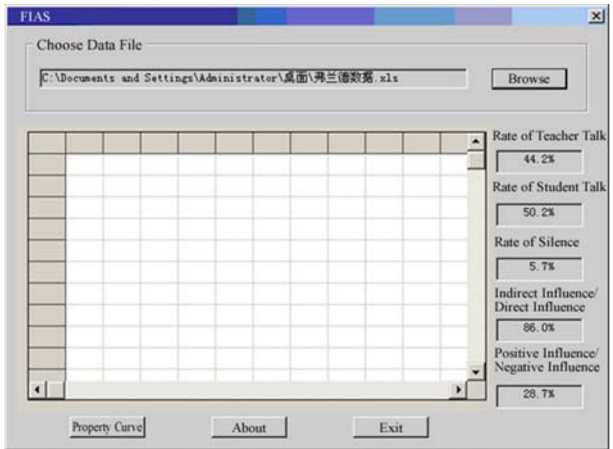

Figure 12. FIAS software interface.

promote difficulty in implementing FIAS. To simplify the data processing of FIAS, our research group developed a software program for FIAS based on the C programming language, as shown in Figure 12. With the FIAS software program, teachers only need to collect raw data and input them into an Excel form. The software program can automatically generate an analysis matrix, the rates of each kind of talk, and the dynamic property curves that describe the corresponding changes.

– How to use the FIAS software

Step 1: Data collection. The student is asked to watch an educational video, which is automatically or manually paused every three seconds. The student then decides what kind of action occurred, records the corresponding code, and inputs the result into the Excel form provided by the software program (Figure 13).

Step 2: Tentative data analysis. After opening the software, the “Browse” button, as shown in Figure 12, is selected, and the data file for analysis is chosen. The results are then automatically calculated by the software program, as shown in Figure 14. The results include the analysis matrix and the rates of teacher talk, student talk, silence, indirect influence, direct influence, positive influence, and negative influence. Subsequently, users can use SnagIt, a screen-capture software program, to capture the results page for future reference.

Step 3: Drawing the dynamic property curves to describe the changes of each talk. Upon selection of the “Property Curve” button, a new window named “Dynamic Property Curve” pops up, as shown in Figure 15. In the figure, the dark bold curve is the dynamic property curve of the rate of the teacher talk, whereas the light curve is for the student discourse. The horizontal axis is the timeline, whereas the vertical axis is the number of teacher (student) talks in one minute.

Step 4: *Generation of the prescription.* According to the prescription generated by method of classroom interaction quality, the class illustrated in Figure 14 falls

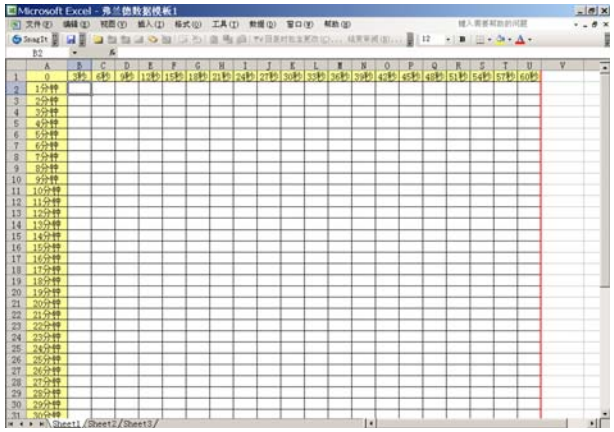

Figure 13. FIAS data recording template.

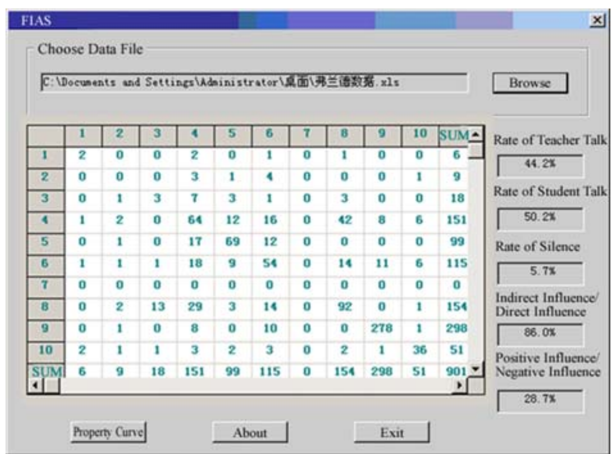

Figure 14. FIAS matrix and ratios of talks.

into the rectangle formed by point (4, 4), (4-8), (8-8), and (8-4), which means that this class has a typical Instruct-Practice mode. Its teacher-student interaction cycle is "teacher asks-students answer-teacher asks again..." as demonstrated in Figure 16. The mode of this class is not Explore-Create, because the teacher has no nine actions, indicating that he or she seldom guides or facilitates the class based on the ideas of the students.

Figure 16 infers that the maximum of all data is 9-9 action, referring to the active talking of students. In the classroom, the teacher divided the students into groups and then assigned them work activities. The students were able to express their ideas

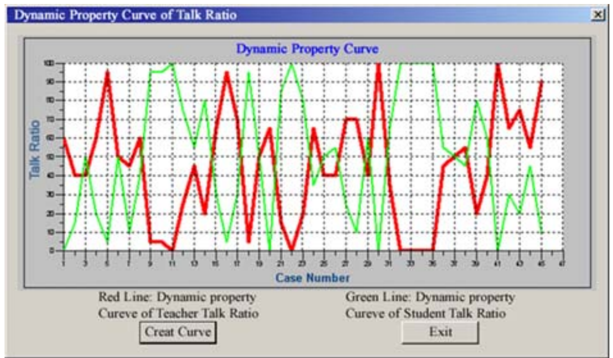

Figure 15. FIAS dynamic property curves of the talk ratios.

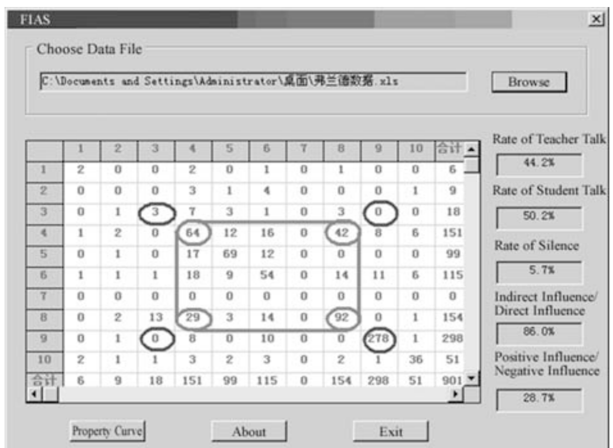

Figure 16. Diagnosis of the FIAS matrix.

actively during the activities, and communicated with each other. Thus, the data recorded "students talk actively."

Figure 16 also shows that the frequencies of the teacher asking, explaining, and instructing, while the students respond are high. The reason is that in this class, the teacher was not giving instructions all the time. She provided the students with opportunities to explore in the form of questions and tasks. The teacher also often asked students or groups several questions, and gave customized hints and instruction during group work. The silence rate in this class is likewise very high (5.7%). The teacher allowed students to think or to calculate, thus resulting in the high incidence of silence in the class. Confusion, on the other hand, is rare. This kind of silence can be accounted as the students' valid action.

Case Review

FIAS is the most popular classroom data sampling analysis system. FIAS is based on verbal actions in a class. Researchers can accurately record the actions and analyze the entire class through the data obtained. The case study emphasized that it is very important for teachers to improve their instructional design and teaching quality. However, this method should be used based on our research needs. In other words, we can customize our research plan by adopting the usefulness of FIAS to various projects. Consequently, we can weaken the limits of FIAS.

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