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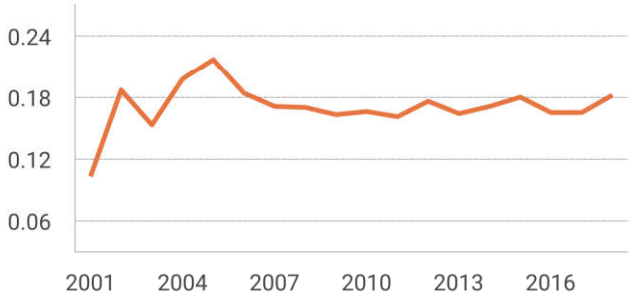

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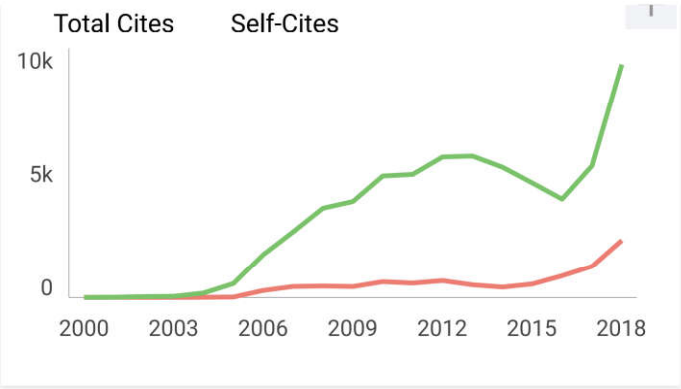
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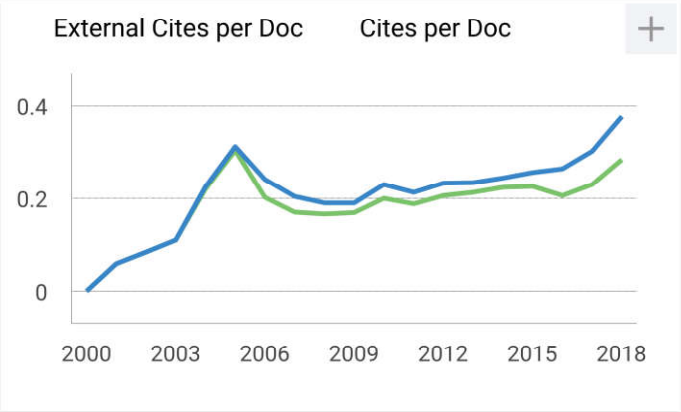
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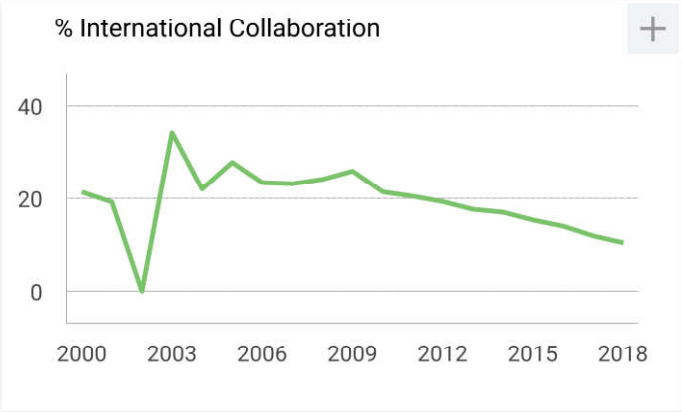
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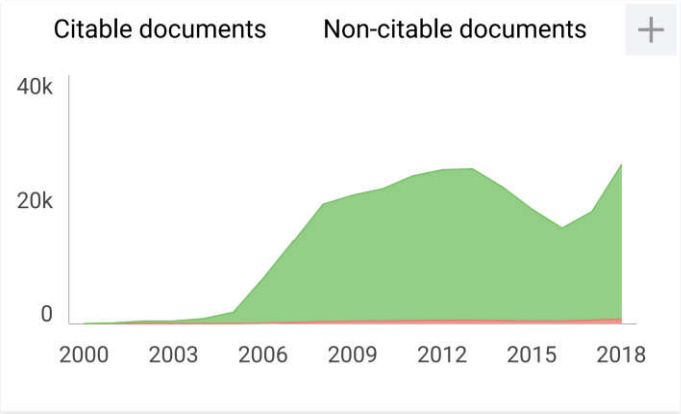
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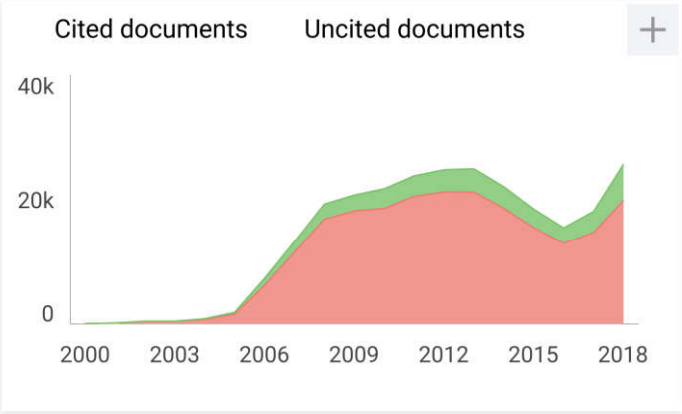
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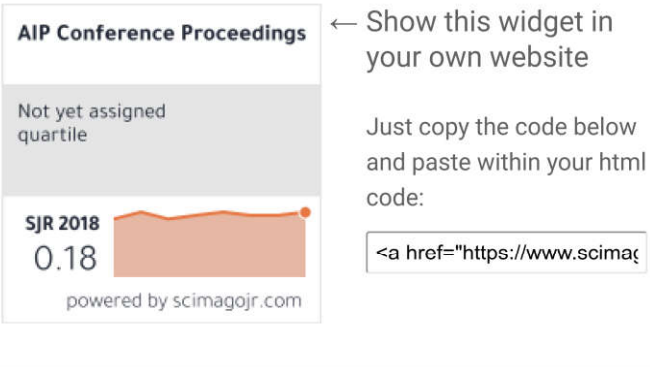
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Silent Method for Mathematics Instruction: An Overview of Teaching Subsets

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Abstract. Generally, teachers use oral communication for teaching mathematics. Taking an opposite perspective, this paper describes how instructional practices for mathematics can be carried out namely a silent method. Silent method uses body language, written, and oral communication for classroom interaction. This research uses a design research approach consisting of four phases: preliminary, prototyping and developing the instruction, and assessment. There are four stages of silent method. The first stage is conditioning stage in which the teacher introduces the method and makes agreement about the 'rule of the game'. It is followed by the second one, elaborating stage, where students guess and explore alternative answers. The third stage is developing mathematical thinking by structuring and symbolizing. Finally, the method is ended by reinforcing stage which aims at strengthening and reflecting student's understanding. In this paper, every stage is described on the basis of practical experiences in a real mathematics classroom setting.

INTRODUCTION

The success of mathematics learning processes cannot be separated from using appropriate learning methods. Brown [1] states that learning method is a way of providing learning materials for students to achieve teaching objectives that have been set. These objectives in mathematics lesson are to develop learners ability to think logically, analytically, systematically, critically, innovatively and creatively, as well as the ability to cooperate [3]. To achieve the objectives, various learning methods, such as scientific methods, problem solving, problem posing, discovery, inquiry, have been developed and implemented. Previous research studies show that the implementations are effective in mathematics instruction. However, there are some findings showing that implementation of learning methods are not effective. This contradiction suggests that innovative learning methods do not always provide meaningful practices and fruitful results when applied in mathematics teaching.

In general, methods applied in mathematics instructions will be either conventional or innovative use of verbal communication. The intensive use of oral communication results in the dominations of teachers during learning processes. This condition trigers the emergence of a new learning method, called "silent way", which is originally implemented in teaching English as a foreign language. Silent way was firstly introduced by Caleb Gattegno in 1972 [2]. Its appearance is based on the idea that teachers should be silent as much as possible in the classroom while students should be encouraged to actively use the language as much as possible [4]. The idea of the silent way method is used as the basis for the development of "silent method" for mathematics instruction. By embracing the same philosophy, silent method for mathematics instruction can be defined as a learning process in which teacher can teach some mathematics concept, by using body language, written, and oral communication for classroom interaction. This research aims to describe the implementation of the method, on its every stage, in mathematics instruction and to know the students' responses to the implementation.

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METHOD

The present study aims to design and develop an intervention (such as programs, teaching-learning strategies and materials, products and systems) as a solution to a complex educational problem. This may advance our knowledge about the characteristics of the interventions along with its design and developmental processes. The main purpose is to develop or validate an educational theory [5]. The subjects of research involve a model teacher and grade seventh students. The teacher is a graduate student of Mathematics Education Program. According to the real teacher of the class, students tend to be less active and show some ignorance during mathematics learning process. The four research stages consist of preliminary (designing the syntax of the silent method), prototyping and developing the instruction (through Focus Group Discussion (FGD) and limited trial), and assessment (conducting field trial and collecting student's respond). Designing syntax of the silent method generates its procedures. The FGD involving expert lecturers, a model teacher, and some junior high school math teachers is conducted to obtain recommendation to revise the initial draft of the syntax. The limited trial to 10 students is carried out to see whether the syntax of the silent method (without speaking) works. This results in a revised version of the syntax where the instruction is not completely in silent mode, but some procedures are communicated orally. The revised syntax is then implemented in the field trial involving 40 students.

RESULTS AND DISCUSSION

The result of this research is a new instruction method that can be used in mathematics instruction called "silent method". Its syntax consists of four main stages, namely: (1) conditioning, (2) elaborating, (3) developing mathematical thinking, and (4) reinforcing. Operationally, these stages are presented in Figure 1.

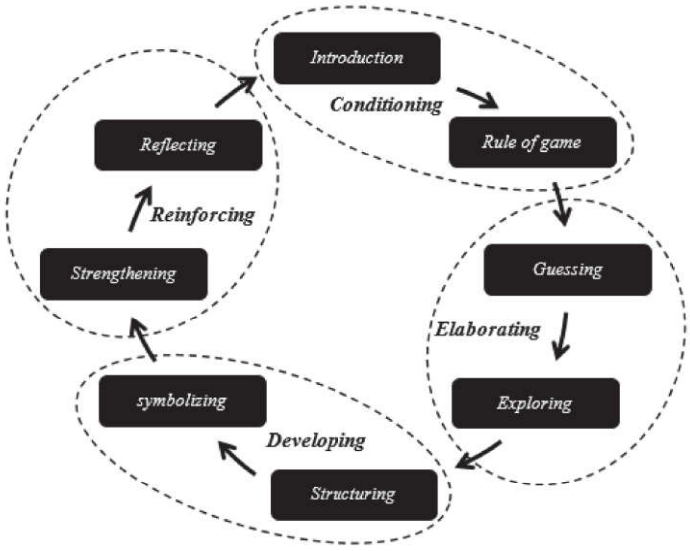

FIGURE 1. Syntax of Silent Method in Mathematics Instruction

The initial stage of the silent method is conditioning stage. This stage aims to introduce silent method to the students, as well as provide a detailed explanation to the students related to learning steps that will be implemented by using the silent method. Moreover, at this stage the students are also given opportunities to ask questions related to the learning process to be carried out. In the next stage, conditioning, teacher will explain rules of the game played in the learning process to students. The rules of the game will be stated in a simple language so that it can be easily understood by students. The rules essentially contain two main things. First, when given a sign of silent (silent mode) by teacher, everyone in the class, including teacher and students, is not allowed to communicate orally. Second, when given a sign of voice (voice mode), everyone in the class may communicate orally. Teacher can provide a symbol or sign to silent mode or voice mode as she wishes, with a note that the symbol or sign can be understood by students and previously agreed.

The second stage in silent method is elaboration. The main activities in this stage are guessing and exploring. All learning processes are in silent mode, therefore guessing activities are conducted without any oral communication. In this case the teacher communicates with the students using body movements or body language assisted with tools that have been prepared by the teacher. In this activity, students are asked to pay attention on what is modeled by the teacher. Then, the students will write the results of his guess on the paper provided. Besides guessing activity in this stage, students also carry out exploring activities. This activity aims to find all possible answers, especially ones that have not been guessed by the students. It also aims to establish patterns or structures that can be used to build a concept of subset and its elements.

The third stage is developing mathematical thinking. This stage consists of structuring and symbolizing activity. Structuring activity will be in silent mode. The purpose of the structuring is to build a concept based on the patterns formed by the previous guessing activity. Meanwhile, symbolizing activities are implemented in voice mode that intends to define the symbols or the rules of writing as a result of generalization of structuring activities.

The final stage in silent method is reinforcing. Reinforcing stage takes place in voice mode so that communication can take place orally. In this stage teacher provides reinforcement on concepts constructed by the students. In this case, the teacher can facilitate this activity by using students' worksheets. In addition, reinforcing stage also carries out reflection activities to clarify any results that have been obtained during learning process.

Mathematics Instruction Using Silent Method

The learning activities using the silent method on subsets material implemented in grade VII F Pangudi Luhur Yunior High School, Yogyakarta, Indonesia are described as follows. First of all, the teacher set up some tools to be used in learning on subsets material. The tools required are one large box, one small box, one book, one tissue box, and one glass. The tools are illustrated in Figure 2.

(a) (b) (c) (d) (e)

FIGURE 2. The tools needed in subsets material learning using silent methods: (a) large box, (b) small box, (c) book, (d) tissue box, and (e) glass

Small box must be able to accommodate all objects (book, tissue box and glass).The symbols of the object should be different. For examples, glass (g), tissue box (t), and book (b). Furthermore, teacher prepares a paper as a medium for students to write answers upon their guessing result.

In the conditioning stage, teacher explains orally the learning objectives so that students can be able to differentiate between subsets and members of the subset. At the same time, teacher explains that silent method will be carried out so there are certain activities in the learning process involving non-verbal communication (silent mode) and verbal communication (voice mode). In this case, the teacher explains that some objects have been moved from the large box to the small one. Students' task is to guess which objects contained in the small box and write up the guesses on paper. One thing that is emphasized by teachers are these activities will be implemented in a silent mode. It means that during the activities students are not allowed to speak.

As a warm up activity, each student is given a paper as a medium for writing guesses made. Teacher put the three objects (book, glass, and tissue) into the large box. Teacher secretly takes some objects (can be1, 2, or 3 objects) from the large box, then put them into little box. Furthermore, by using a sign language, the teacher asks the students to guess objects in the small box, and write the results of his guess on paper that has been provided. After the students finished writing their guesses, teacher asked five students to write the answer on the board in front of the class. The teacher opens the small box and shows the objects inside to the students. The teacher gives a thumbs-up for students who write correct guesses. After the simulation process is completed the teacher prepares students for conducting elaboration stage.

The activities in the next stage, elaborating started with guessing in a silent mode so that students can focus more on the task given. In making guesses, initially students rely solely on their intuitions and write down everything that comes up into their minds in an informal language such as the names of the objects. They have not yet come to symbols that can signify the objects. This kind of guesses can be referred as random guesses. If their random guesses are correct, they cheer happily. This process is repeated on and on in exploring stage to give opportunities to students to think mathematically and develop refined strategies to guess, namely educational guess. Using this advanced strategy, students can list all the correct possibilities that come into their minds. In fact, only few number of students who can come up with all possible correct answers. The results of students' guesses after guessing five times can be seen in Figure 3a.

(a) (b)

FIGURE 3. (a) The results of students' guesses after guessing as much as five times, (b) students' guess results in a clear structure

For the next stage developing, the teacher organizes the results of students' guesses in a clear structure as shown in Figure 3b.Teacher introduces how to write a set symbol formally, i.e. { }, and students replicate the symbol. Then, teacher asks the students to discover the structure of the eight subsets based on students' guesses. The structure is given in Table 1.

TABLE 1. The structure of the 8 subsets based on students' guess

The number of objects taken	The possibilities of objects taken
3	{Book, Tissue box, Glass}
2	{Book, Tissue box}; {Book, Glass}; {Tissue box, Glass}
1	{Book}; {Glass}; {Tissue box}
0	Empty

From the structure formed, the teacher guides students to write notation of the set. In this case each object is symbolized as follows: Book = B; Glass = G; and Tissue = T. Afterward, the teacher asks some students to write all possibilities of subsets corresponding to objects that have been taken. For example, if glass and book are in the small box, students only need to write "{G, B}".

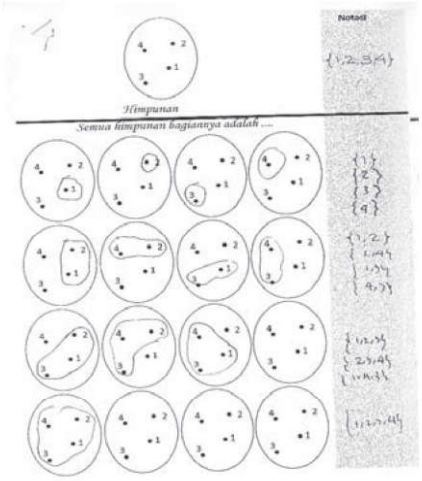

FIGURE 4. Example of students' work

In the penultimate phase, strengthening, the teacher distributes worksheets to emphasize students' understanding on the concepts studied. One example of students' work is given in Figure 4. The last stage, reflecting, the teacher ask some selected students to express what they have learned, especially the concepts they have been mastered.

Analysis of Student Response toward the Learning Process with Silent Method

There are four aspects that we want to know related to students' responses on silent method in mathematics, namely the understanding of the material being studied, the interest in the method, the feeling during the lesson, and perceptions related to the future application of the method. The students' responses are measured using a questionnaire. Recapitulation of students' responses in silent method learning process is presented in Table2.

TABLE 2. Recapitulation students' respon to questionnaire

No.	Aspect	Responses			
1.	Understanding of the material being studied	Excellent 2 (5%)	Good 4 (10%)	Fair 21 (50.25%)	Poor 13 (30.25%)
2.	Interest in the method	Very interested 3 (7.5%)	Interested 18 (45%)	Fairly interested 15 (37.5%)	Not interested 4 (10%)
3.	Feeling during the lesson	Very happy 5 (12.5%)	Happy 23 (57.5%)	Fairly happy 10 (25%)	Not happy 2 (5%)
4.	Perceptions related to the application of the method further	Stongly agree 5 (12.5%)	Agree 15 (37.5%)	Less agree 18 (45%)	Not agree 2 (5%)

From Table 2, it can be seen that only 5% of students having excellent understanding of the material, while 10% are in the good category, 50.25% are in fair category, and 30.25% are in the poor category. Based on these results, in general, it can be concluded that students' understanding to the material being studied is still low. It is because students have not been introduced to the concept of set and the material taught in the field trial, subsets needs it as a prerequisite. It means that if the basic concept is not good, it is normal that students still have difficulty in understanding the next material. However, it is important to give appreciation to the students who are good and excellent in understanding the concepts. This demonstrates the applicability of silent method that can help students understand the concept of subsets, although the initial set concept has not been learned. Although the methods used are still in the process of development, a positive impact on students' understanding of the concept has emerged.

Silent method in mathematics learning is new to both teachers and students. This will certainly lead to perceptions of both teachers and students related to their interest in this new method. Table 2shows only10% of students stating not interested in the silent method, whereas students interested in silent method are more than 50% (7.5% state very interested, 45% state interested), while the remaining 37.5% of students state that silent method less

interesting for them.As a whole, it can be concluded that the use of silent method in mathematics instruction gives a positive impact on students' interest. Although the percentage of studentsless interested still quite high, we believe that this is caused by the students'state that is not ready to experience a new learning method so they still requires a process of adaptation.

From Table 2,approximately 70% (12.5% stated very happy, 57.5% stated happy) of students say that they are happy with the silent method, while the remaining, approximately30% of students, still give negative responses. Looking at these results, it can be concluded that the application of the silent method in mathematics can developenjoyable learning environment for most students.

According to data stated in Table 2, about 50% of students agree with the implementation of silent method in the future mathematics instruction, while the remaining are reluctant if this method is applied again. Observing this, the proportion of students who agree and disagree is quite balanced, meaning that improvements in the design of learning methods are necessary to make students feel more comfortable with the learning process. Apart from that, we also believes that the novelty factor of the methods implemented also contributes negatively to the students' responses. Thus, over time and improvement made, it is expected to have a positive impact on the students' interest and motivation in mathematics instruction.

CONCLUSION AND RECOMMENDATION

As a conclusion, the silent method for mathematics instruction operationally implemented through the following syntax: (1) conditioning stage which introduces the method and makes agreement about the rules of the game; (2) elaborating stage which concerns with guessing and exploring alternative answers; (3) developing mathematical thinking stage which consists of structuring and symbolizing; and (4) reinforcing stage which aims at strengthening and reflecting. In general, almost 50% of students give positive responses toward the implementation of silent method in mathematics instruction.

Furthermore, the silent method for mathematics instruction still needs to be developed further. It aims to increase students' positive response in the following study with the silent method. The main obstacle is related to student management since there are still many students who do not follow the learning process actively. Thus, it is necessary to encouragestudentengagement that can support the implementation of the silent method.

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