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AN INVESTIGATION INTO DIALOGUE USED IN TEACHING MATHEMATICS

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Abstract

The article examines the basic concepts of dialogue and its importance in teaching and learning Mathematics, which confirms its benefits in reinforcing positive learning and developing critical thinking among students. In addition, the paper proposes some techniques in the process of dialogue as a result of conducting an observation of dialogue in practice.

1 Background

Critical thinking is really necessary for us in daily activities. Interest in teaching and developing critical thinking has improved significantly in latest years. Strategies for fostering students to develop critical thinking abilities are flouring in mathematic. The classroom dialogue presents to be an achievable strategy for both teaching and applying critical thinking skills. Following this concern, the Classroom Discourse Project (Cormack et al., 1998) has been widely developed since Wilkinson's poineering research on classroom communications and interactions through classroom talk. The project sought to describe classroom practices that enhance listening and speaking skills through different subjects. The projects results indicated pupils positive ability to talk to demonstrate what they had learned. Especially, the results also showed that teachers have a strong influence in shaping the conversations to support pupils learning.

Recently, extensive research in dialogue use was conducted in five countries which are UK, USA, Russia, France and India (Alexander, 2005). The

Key words: dialogue, critical thinking, teaching, learning, techniques.

research specifically focused on dialogue in the classroom and it was revealed that there are many similarities in dialogue use among teachers in the participating countries. However, teachers in France and Russia used dialogue method more significantly than the others, which was beneficial to students learning outcomes, as well as their behavior development in the classroom.

This article is aimed at discussing some aspects of dialogue, its characteristics, and making a few remarks after observing dialogue use in a mathematics class.

2 Research content

2.1 The dialogue

2.1.1 The concept of dialogue and its importance for teaching

Although the concept of dialogue has existed for a long time, there is still not a standard definition. Nevertheless, we can clearly understand that dialogue does not only mean talking or sharing ideas but it also refers to structured dialogue or an extended process leading to new insights, knowledge to bring about understanding and learn efficient practices. In other words, dialogue takes place not only in stories, presentation, debates or arguments, but more important it involves solving problems and developing new ideas. The development of using dialogue in the classroom indicates that teaching is a process of systematic dialogue in order to find and expand in-depth knowledge and understanding for the sake of developing students thinking. However, the dialogue must be in scaffolding.

The MIT Center for Organizational Learning has claimed that using dialogue in teaching brings many benefits to learning: dialogue provides the foundation for organizational learning; dialogue is an effective method to pioneer teams intelligence or two participants, which expand and deepen the process of collective discussion; dialogue suggests the possibility of a significant breakthrough in the way people can adjust themselves, whether in public or private; and the dialogue can be seen as an alternative method to create innovative collaboration among active groups.

2.1.2 The benefits of using dialogue in teaching

The Australian Council for Educational Research (ACER) in the NSW Institute of Teachers confirmed the truth that participating in a dialogue, pupils, on the one hand, will increase the confidence, develop communicative skills, and get more knowledge from their classmates. Moreover, they have opportunities to organize cooperative activities and know how to create good relationships with other peers. On the other hand, they develop and practice some crit-

ical thinking skills, such as narrate; explain; instruct; ask different kinds of questions; receive, act and build upon answers; analyse and solve problems; speculate and imagine; explore and evaluate ideas; discuss; argue, reason and justify; negotiate.

The students also develop four important skills to interact effectively with the others: listen; be receptive to alternative viewpoints; think about what they hear; and give others time to think .

2.1.3 The characteristics of a dialogue

In the book titled Communication and the Ground of Dialogue Cissna, K. N. and Anderson,R (1994) generated eight basic characteristics of dialogue, which are: Immediacy of Presence; Unanticipated consequences; Recognition of "strange otherness; Collaborative orientation; Vulnerability; Mutual implication; Temporal flow; and Genuineness and authenticity.

2.1.4 Dialogue organization in teaching mathematics

Basing on dialogues characteristics, a process is proposed in order to illustrate an effective method in teaching maths, which is shown in Figure 1

2.2 The observation

A dialogue is organised and observed its progress in a 12^{th}-grade class of 45 pupils at a high school in An Giang province

2.3 Some findings

- *Everyone was engaged in the dialogue:* in order to each people attend learning.
- *Teacher talk did not over-dominate in the dialogue:* teacher is not only the main speaker, but teacher also listens secrectly during discussions student, teacher is just give several opened questions, further questions to push and encouraged students thinking whenever it is so essential.
- *Participants exchanged ideas and supported each other:* when doing dialogue, student completely talk coopertively, scaffolded without competition.
- *In the course of conversation, peoples responses were produced basing on what others had contributed:* this feature means everyone interacting in dialogue will be given the acceptable answers for their ideas.
- *Students' contributions were well-developed sentences or phrases:* it requires good behaviour from participants

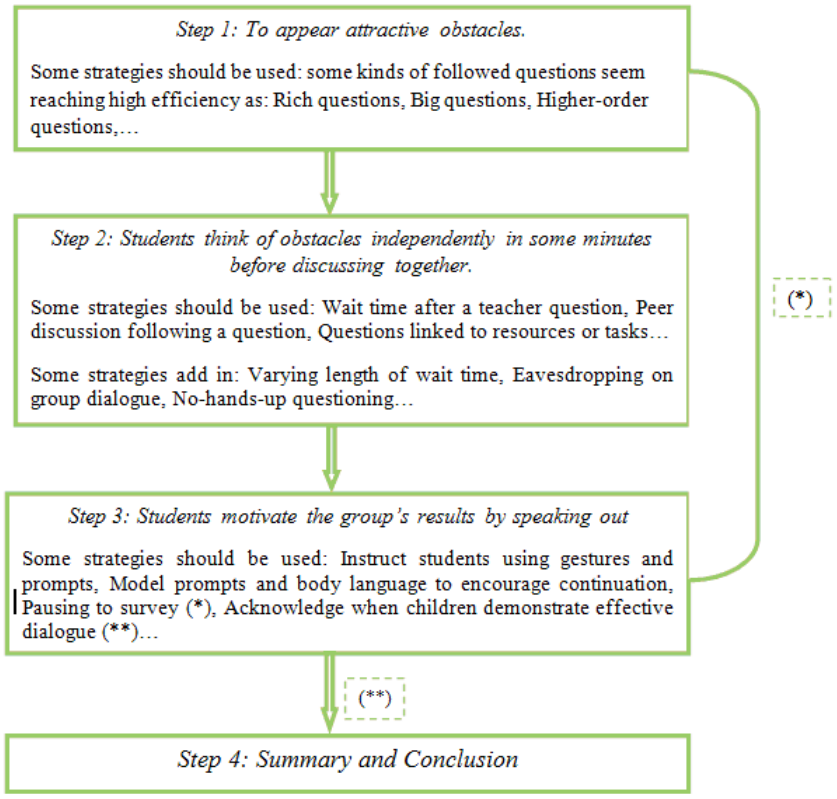

Figure 1: Process of dialogue in teaching mathematics.

- *Students were willing to take risks by sharing partial understanding:* this feature denotes everyone always accepts to share own knowledges despite of being able to get back new things or not.

- *Students were willing to challenge each other's ideas in a constructive way:* this aspect shows that students ready to listen, think carefully and ask various questions without hesitancy around the ideas to understood clearly and exactly problems.

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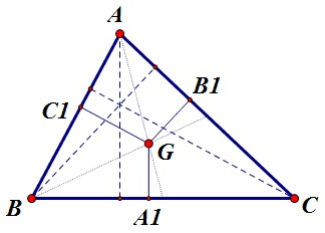
2.3.1 Observation procedure

- A handout is designed to prepare for a dialogue in the following problem:

- Assign pupils in groups of 5, each group is allowed 14 minutes for discussion and 5 minutes for presentation; brief conversations among 5 students are recorded.

Given is the triangle ABC with three sharp corners, in which G is the central point, are the length of the three sides of the triangle. From G, are perpendicular to the sides BC, CA, AB. Verify that the following is true: $a^2\overrightarrow{GA_1} + b^2\overrightarrow{GB_1} + c^2\overrightarrow{GC_1} = \overrightarrow{0}$ (1)	

- Observation sheets are used to take notes of the process of the following tasks:

Task 1: Ensure that all students are involved in the dialogue process.

Task 2: Students listen to each other, share ideas and consider alternative viewpoints.

Task 3: Students articulate their ideas freely without fear of embarrassment over wrong answers and help each other to reach common understandings.

Task 4: Students build on their own and the others ideas and chain them into coherent lines of thinking and enquiry.

Task 5: Teachers encourage their students to use clear, appropriate language; and the teachers use of prompting questions helps build on students responses and motivate them to take their thinking further.

2.3.2 Results and discussions

Generally, all of the tasks were fulfilled successfully and every student was involved in the dialogue process as they listened to each other. We just analyse about dialgue at group 2 which had considerable fluctuations.

As for the teachers:

- The teachers built their questions more carefully. Questions beginning with What, Who and How many were used in place of those with Why and How.

- The teachers were gradually less direct and less control over discussions. In contrast, they motivated and facilitated the students to take the initiative.
- The exchanges among students and teachers were becoming longer and more cooperative. Teachers and students worked together to build dialogues based on questions and answers by applying key strategic questions (giving one particular topic to each student) rather than using war rotation strategies (questioning the whole class).

Teacher (T): *we are given triangle ABC with three sharp corners, in which G is the central point, are the length of the three sides of the triangle. From G, are perpendicular to the sides BC, CA, AB. Who can verify that the following is true:*

$$a^2\overrightarrow{GA_1} + b^2\overrightarrow{GB_1} + c^2\overrightarrow{GC_1} = \overrightarrow{0}. \quad (2)$$

Students (STS): get ready to start.
T: I'd like you to work in groups of five to solve in problem
S1: what should we do?; ST2, 3: demonstrate an expression equal to vector zero.
S4, 5: how can we do it?...
S5, S1: Oh, It's very simple. This one is okay:

$$\begin{aligned} a^2\overrightarrow{GA_1} + b^2\overrightarrow{GB_1} + c^2\overrightarrow{GC_1} &= \overrightarrow{BC}.\overrightarrow{BC}.\overrightarrow{GA_1} + \overrightarrow{CA}.\overrightarrow{CA}.\overrightarrow{GB_1} + \overrightarrow{AB}.\overrightarrow{AB}.\overrightarrow{GC_1} \\ &= \overrightarrow{AB}.0 + \overrightarrow{BC}.0 + \overrightarrow{CA}.0 = 0 \end{aligned}$$

S2, S3, S4: That is so simple, isn't it?; S3: there is something wrong with it
S5: how? It's true that the scalar multiplication between two perpendicular vectors is 0 [Silence ...]
T: Have you used all of data yet?
S4: What's the matter, suppose ....[thinking ..]
S2: Ehhhh, the assumption that G is the central of the triangle is not used? So, with such proof, the result does not depend on the position of the G?, So it is for G to do more?
S1: here, it is $\frac{4S^2}{9} - \frac{4S^2}{9}.\frac{b}{a}\cos C - \frac{4S^2}{9}.\frac{c}{a}\cos B = \frac{4S^2}{9}\left(\frac{a - b\cos C - c\cos B}{a}\right)$
S2: Okay, the result is a number, but it proved to be told by the vector 0, the results can prove anything????
T: the end result looks like?
S3: It's zero.
T: So the scalar *multiplication* **of the two vectors is 0, right?**
T: So the scalar multiplication of the two vectors is 0, right?
T: look at all the threads, tell me what it requires?
S1: let's say $a^2\overrightarrow{GA_1} + b^2\overrightarrow{GB_1} + c^2\overrightarrow{GC_1} = \overrightarrow{0}$
T: So what would happen if $a^2\overrightarrow{GA_1} + b^2\overrightarrow{GB_1} + c^2\overrightarrow{GC_1} = \overrightarrow{0}$*?. Who can let everyone know???*

S5: Well, the vector 0 scalar multiplied by a vector without vector 0 is equal to 0.

As can be seen from the dialogues, the students were actively involved in solving the problems. It is not important for teacher to care how students talked to each other. It matters to focus on how they solved the problem. Teachers were secretly listening to the student's discussions and contributing only when they needed suggestions based on what they had found.

*) The responses of the students to the task 2, 3, 4 can be seen as:

- The contribution of diverse students, rather than just stopping at proving, explaining and describing
- The students demonstrated self-confidence as they responded to the task more easily, transparently and clearly. Moreover, they were speculating, thinking, and helping each other.
- There were more than an exchange between students and students.
- Students offered more answers to the teachers' questions.
- More and more students were actively commenting or asking their own questions, whichs combines flexibility among memos, presentations and discussions
- Students initiative provided information and opinion to create a balance between questions and explanations, so the thinking of Mathematics was also flourished.

S5, S1: Oh, It's very simple. This one is okay:

$$\begin{aligned} a^2\overrightarrow{GA_1} + b^2\overrightarrow{GB_1} + c^2\overrightarrow{GC_1} &= \overrightarrow{BC}.\overrightarrow{BC}.\overrightarrow{GA_1} + \overrightarrow{CA}.\overrightarrow{CA}.\overrightarrow{GB_1} + \overrightarrow{AB}.\overrightarrow{AB}.\overrightarrow{GC_1} \\ &= \overrightarrow{AB}.0 + \overrightarrow{BC}.0 + \overrightarrow{CA}.0 = 0 \end{aligned}$$

S2, S3, S4: That is so simple, isn' it?; S3: there is something wrong with it
S5: how? It's true that the scalar product of two perpendicular vectors is 0. [Silence ...]
T: Have you used all of data yet?
S4: What is the matter, suppose [thinking ..]
S2: Ehhhh, the assumption that G is the central of the triangle is not used? So, with such proof, the result does not depend on the position of G?, So it is for G to do more?
S1, S3, S5: uhmmmm, let me review; S5: but this proof was wrong at one place? where is it?
S1: Why was it wrong? It is not a truth in saying that there is a combined feature in scalar product of more than two vectors .
Teacher: Great!!!! It is exactly, we were mistaken in that thing, Let's continue!.
S1: G is the center of the triangle. Followed by the ratio of focus, we will have

the length of GA_1, GB_1, GC_1 are one third of the line drawn down from the top edge.
S2: so what? We will stick to it well; ST 5: try it, or use properties to add vectors?
S4: I tried but it's not results. It's more complex and messy. Haizzzz, where is the key? Must be based on point G so the ratio of the length of GA_1, GB_1, GC_1 will be one third of the height, so bring on the height with it?
S3: take the height is not a good solution, Ahhhh, this place, I feel the height's appearance with the bottom edge, and that each element has the same value of 1/3, the analysis goes on for 1 minutes without any results found. [Also no results]
S2: the height of the bottom edge is related to the area? if so, try to make the area appear to go. Try to calculate the length of $\overrightarrow{GA_1}$ by using 1/3 of AH. I have this:

$$\begin{aligned}\left(a^2\overrightarrow{GA_1}+b^2\overrightarrow{GB_1}+c^2\overrightarrow{GC_1}\right)\overrightarrow{GA_1} &= a^2\overrightarrow{GA_1}^2+b^2\overrightarrow{GB_1}\overrightarrow{GA_1}+c^2\overrightarrow{GC_1}\overrightarrow{GA_1}\\ &= \tfrac{1}{9}a^2h_a^2+b^2\overrightarrow{GB_1}\overrightarrow{GA_1}+c^2\overrightarrow{GC_1}\overrightarrow{GA_1}\end{aligned}$$

S1: Wait a minute, continue to develop that scalar multiplication
S2: scalar product of vectors, huh? What do we have after then?
S3: yeah, this way, do it all, 1 minute to do. Then, right here, this result:

$$a^2GA_1^2-b^2GA_1GB_1\cos C-c^2GA_1GC_1\cos B=\frac{1}{9}a^2h_a^2-\frac{1}{9}b^2h_bh_a\cos C-\frac{1}{9}c^2h_ah_c\cos B$$

S4: wait, wait.., why two minus appeared, ST3? Those are two plus, and why it appeared, angles B and C ?
S1: because they are quadrilateral inscribed circle, so the cosine of that angle is equal to the cosine of the angle B and the angle C with minus.
S4: ok, ok ..;ST 3: here, we will make the area appear
S1: here, it's here

$$\frac{4S^2}{9}-\frac{4S^2}{9}.\frac{b}{a}\cos C-\frac{4S^2}{9}.\frac{c}{a}\cos B=\frac{4S^2}{9}\left(\frac{a-b\cos C-c\cos B}{a}\right)$$

S2: Okay, the result is a number, but it proved to be told by the vector 0, the results can prove anything????
T: So what would happen if $a^2\overrightarrow{GA_1}+b^2\overrightarrow{GB_1}+c^2\overrightarrow{GC_1}=\overrightarrow{0}$?. Who can let everyone know?
S5: Well, the vector 0 scalar multiplied by a vector without vector 0 is equal to 0
S3: aaaaaa, so I just have to do a similar thing again.
S1, 2, 4, 5: What do you mean? It's confusing.
S3:That means vector 0 multiplied by any other vectors is equal to 0, so I'll go on and show you how: $\left(a^2\overrightarrow{GA_1}+b^2\overrightarrow{GB_1}+c^2\overrightarrow{GC_1}\right)\overrightarrow{GB_1}=0$, I think it is only the same, let's do it.

S2: Let me do it myself. [....]. [All groups focus on ST2]

$$\begin{aligned}\left(a^2\overrightarrow{GA_1}+b^2\overrightarrow{GB_1}+c^2\overrightarrow{GC_1}\right)\overrightarrow{GB_1} &= -a^2GA_1GB_1\cos C+b^2GB_1^2-c^2GB_1GC_1\cos A\\ &= -\tfrac{1}{9}a^2h_ah_b\cos C+\tfrac{1}{9}b^2h_b^2-\tfrac{1}{9}c^2h_bh_c\cos A\\ &= -\tfrac{4S^2}{9}.\tfrac{a}{b}\cos C+\tfrac{4S^2}{9}-\tfrac{4S^2}{9}.\tfrac{c}{b}\cos A\\ &= \tfrac{4S^2}{9}\left(\tfrac{b-(a\cos C+c\cos A)}{b}\right)=0\end{aligned}$$

S3: Done, the problem has been resolved.
S1: Oh, I still do not understand only one thing, S3. It's the reason why

$$\frac{4S^2}{9}\left(\frac{a-b\cos C-c\cos B}{a}\right)=0$$

$$\frac{4S^2}{9}\left(\frac{b-(a\cos C+c\cos A)}{b}\right)=0$$

S3: This relates to the nature of the height in the triangle, I will explain, but we must finish the task first;
ST 1: ok, ok, ...

*) Dialogue attracts slightly ability students participating into learning, this is a problem that experts have been trying to improve. Having engaged in dialogues, the students were provided with the opportunity to perform and progress. Indeed, they felt calmer, more confident, and less suppressed because of unfocus, they did not have the feeling of being competitive.

*) The students mastered mathematics skills during the learning process and teachers only acted as facilitators. The students reflected their serious learning although they had to stand up or leave their chairs to present to the others in the group or to hear their ideas.

*) In groups, the weak students also joined in and expressed their thoughts, due to all of their comments will be raised, not be chained together

*) The students knew how to listen to the others' opinions and how to use other thoughts to explore new things for themselves. This was highly appreciated because it reflected the development of thinking, especially critical thinking.

2.4 The difficulties of using dialogue in teaching mathematics

Interim results from the evaluation of the program show that classroom talk has become dialogue in terms form and quality. When participating in a classroom dialogue, pupils will have the opportunity to develop and practice

some critical thinking skills such as narrate; explain; instruct; ask different kinds of questions; receive, act and build upon answers; analyse and solve problems; speculate and imagine; explore and evaluate ideas; discuss; argue, reason and justify; negotiate. The students also develop four important skills to interact effectively with others such as listen; be receptive to alternative viewpoints; think about what they hear; and give others time to think.

However, the organization of teaching and learning by using dialogue has certain difficulties, which are:

- When organizing dialogues, teachers need to give students the language and necessary skills to achieve the learning objectives. Also, teachers need to have the skills to use dialogue smartly to help students achieve success in learning.
- Dialogue is a method of teaching which needs adequate knowledge and communication skills to support students.
- Actually in the research, there is a significant gap among the teachers who are making changes and those with very little change. In addition, the proportion of qualified teachers is very small.
- Although students have more time to think about the participants' feedback and are encouraged to regularly make expanded answers, it seems that the answers to the feedback only based on what they find.
- The exchange between two people does not seem to create the attention needed to focus on issues of learning and capacity building system of students.

2.5 Some effective strategies for teaching dialogue

This research is done based on theory of teaching dialogue step by step and it is completely reflected in the above findings.

This study reinforced the view of the research from ACER, which helped with realising some useful strategies to interact in a dialogue: *whole class teaching; collective group work; collaborative group work; one-to-one teaching; and one-to-one activity between pairs of students (Alexander, 2005).*

There are also common strategies to promote children's learning through classroom talk such as: inculcation of facts, ideas and routines in their mind by repetition; the accumulation of knowledge and understanding through questions designed to test or stimulate recall; conveying information, illuminating facts, principles and procedures, providing instructions; exchange of ideas with a view to sharing information and solving problems; and achieving common understanding through structured, cumulative questioning and discussion, which guide, prompt, reduce choices, minimize risk and error and facilitate the internalising of concepts and principles by students.

3 Conclusion

There is no denying that when working with a really talented peer, students need to acquire knowledge to think and to do better. And when actively involved in guiding the learning activities and conversations, students not only get information, but also learn how to use this information in transforming and making it become his knowledge. An important aspect in the use of discussion and dialogue in teaching is when students witness a discussion between the teacher and their peers, which will then have positive effects on their learning. Indeed, when receiving the concepts and ideas from classmates, and seeing the process of proving exchanges, the discussions will help students acquire new knowledge and turn it into their own knowledge. In addition, during the dialogue, students will have the immediate feedback and targets for the accuracy or appropriateness of the ideas. However, it is worth pointing out that discussion and dialogue are the most effective when they are collaborative rather than competitive.

Dialogue can be an important part of the handover process of knowledge and skills. Dialogue arouses participants' thinking when they cannot do it alone and recognize these thoughts as their minds develop. The purpose of increasing the number of students participating in conversations in the classroom is not only to allow students to express their opinions, but also build students' confidence or communication skills. The main purpose of using dialogue in teaching is to change students' awareness of thinking and understanding when talking about a certain issue. It is believed that the use of dialogue in teaching is the most effective way for the development of thinking skills, especially critical thinking.

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