RESOLVING COGNITIVE CONFLICT WITH PEERS – IS THERE A DIFFERENCE BETWEEN TWO AND FOUR?
Hagit Sela and Orit Zaslavsky
Technion – Israel Institute of Technology

This paper focuses on both inhibiting and enhancing social aspects of cognitive conflict. Our research examined cognitive conflict situations that occurred while students dealt with mathematical contradictions in two social settings: peer groups of two or four students. We identified different types of on-task social interactions between groups of the different sizes. These differences were perceived by the students as contributing to or obstructing the conflict resolution and learning outcomes.

WHY DEAL WITH COGNITIVE CONFLICT?

Evoking cognitive conflict is often treated as a teaching strategy which may contribute to learning. Thus, several researchers treat the conflict teaching approach as a means of helping learners reconstruct their knowledge (Tirosh & Graeber, 1990; Niaz, 1995; Swan, 1983; Behr & Harel, 1990; Movshovitz-Hadar, 1990).

Cognitive conflict results in a state of disequilibrium - a Piagetian term meaning lack of mental balance. It is essential to the occurrence of what Piaget termed 'true learning', that is the acquisition and modification of cognitive structures. A conflict can lead to dissatisfaction with existing concepts, which is a crucial phase of conceptual change (Posner et al., 1982). Cognitive conflict is usually a tense state (Zaslavsky et al, 2002). Berlyne (1960) claims it plays a major role in arousing – a strong incentive to relieve the conflict as soon as possible. Relating to its tensed character, researchers point to situations where cognitive conflict could cause difficulties, problems, and even dangers to the learning process. For example, if the conflict is excessive, it could lead to withdrawal, anxiety or frustration (Dreyfus et al., 1990; Movshovitz-Hadar & Hadass, 1991; Behr & Harel, 1990). Some researchers claim it can even break down the learners current internal structures (Duffin & Simpson, 1993). Being aware of these two contrasting sides of the conflict strategy, we felt challenged and fully motivated to search for characteristics of the conflict resolution process which enhance or inhibit learning.

Most of the research in mathematics education uses cognitive conflict as a strategy to develop students' awareness to their misconceptions. The understanding state of students is documented as a starting point A, and the conflict situation aims to transfer the student to another target point B. The students' responses to mathematical questions before and after the conflict experience are the main milestones of these studies (E.g., Swan, 1983; Movshovitz-Hadar, 1990; Tirosh & Graeber, 1990). As a result, little is known about the characteristics of conflict resolution process. This study examined the
processes involved in students' attempts to resolve mathematical cognitive conflict situations.

WHY WORK IN SMALL GROUPS?

Many studies support learning in small groups (e.g., Leikin & Zaslavsky). Researchers argue that interaction among students on learning tasks could lead to improved achievement. The interaction brings students to learn from one another because in their discussions of the content, cognitive conflicts are aroused, inadequate reasoning is exposed, and higher quality understanding could emerge. Through mutual feedback and debate peers motivate one another to abandon misconceptions for better solutions (Slavin, 1995; Mugny & Doise, 1978).

However, there are researchers who point out to some aspects that are worthwhile considering before planning working in small groups. A basic character of the situation of working on mathematical tasks in a group is that students have to face two kinds of problems: a mathematical one and a social one (Laborde, 1994). Therefore, we should expect social behaviors which affect the learning process. For example, because of self-esteem, students might refuse to recognize that they are wrong, or others might refuse to accept the validity of their mates' arguments because they contradict theirs (Balacheff, 1991). Attention to these aspects brought us to inquire the connections between group work and learning; particularly, does it support learning through cognitive conflict? In addition, Findings from a pilot study raised our attention to different characteristics of group work processes which seem to depend on the group size.

RESEARCH GOAL

Stemming from the questions above, we wanted to find whether there are differences between two group sizes dealing with mathematics contradictions. Thus, the goal of the study was to point to main differences and commonalities between cognitive conflict-resolution processes of pairs vs. groups of four.

RESEARCH DESIGN AND METHODOLOGY

In order to create genuine cognitive conflict situations we selected 4 tasks with the potential of evoking conflict, Tasks 1 & 3 were of familiar content, while Tasks 2 & 4 were of unfamiliar content (the number of the tasks indicates its order of appearance for the students). In our paper we focus on findings from Tasks 1 & 3. These tasks, in addition to several others, were tried out with other groups of students at an earlier stage in order to support this claim. Once the tasks were determined, eight 17 years old top-level secondary school students were invited to take part in the main study. All students worked on all four tasks in the same order. Each experienced both settings – on two of the tasks working in pairs and on the other two – working in groups of four. In this paper, we focus on findings from Tasks 1 & 3, for all students. Half the students
worked on Task 1 in pairs and on Task 3 in groups of four, and the other half worked on Task 1 in groups of four and on Task 3 in pairs.

Each task began with an individual assignment, in which each student was asked to solve a mathematical problem on his or her own, in writing. After solving the problem alone, the members of the group were asked to discuss their solutions and reach an agreement. When an agreement was reached, the group was confronted with an alternative contradicting approach. They were then asked to resolve the contradiction as a group.

Each student was interviewed 3 times throughout the study. In these interviews the students were invited to share with the researcher their experiences and feelings regarding the conflict resolution processes. In addition, a final meeting with all 8 students was held after completion of all tasks. In this meeting, the researcher discussed with the students the underlying mathematics associated with the contradictions with which they were presented.

All sessions were videotaped and transcribed. Students' interviews were audiotaped and transcribed. Students' written solutions to the core parts of the tasks were collected and analysed.

Research instruments

The central research instrument consisted of the tasks presented to the students.

The Tasks:

Each task had a core part, given at the initial stage. Then, according to the group's progress, an alternative approach to the problem was introduced, the aim of which was to evoke conflict when conflict was not encountered spontaneously. In general, different approaches could arise naturally by group members which could lead to contradiction. As researchers, we wanted to make sure that if the contradicting solutions do not appear naturally, we would interfere in this direction.

Task 1:
Core Problem: \[ \sqrt{x-2} \geq 4-x \]

Anticipated student solution: Being familiar with students' common errors, we assumed most of them would raise the two sides of the inequality to the power of 2 without taking into account the signs of the terms, so their solution would probably be as followed:

\[
\begin{align*}
\sqrt{x-2} & \geq 4-x \\
x - 2 & \geq 16 - 8x + x^2 \\
x^2 - 9x + 18 & \leq 0 \\
(x-3)(x-6) & \leq 0 \\
3 & \leq x \leq 6
\end{align*}
\]
An alternative (contradicting) Approach: We used the following graphical representation, which emphasized the fact that the solution is an open range, contrary to the group's anticipated solution.

Nurit's solution: \( x \geq 3 \)

Reasoning:
Drawing the graphs of \( y = 4 - x \), \( y = \sqrt{x - 2} \) indicates the two graphs have one interception point at \( x = 3 \).
For all values of \( x \) bigger than 3, the graph of \( y = \sqrt{x - 2} \) is above the graph of \( y = 4 - x \).

Task 3:
Core Problem: Solve the following equation: \( \sqrt{x^2 - 4x + 4} - \sqrt{x^2 + 6x + 9} = 3 \)

Anticipated Student Solution:
\[
\sqrt{x^2 - 4x + 4} - \sqrt{x^2 + 6x + 9} = 3 \\
(x - 2)^2 - (x + 3)^2 = 3 \\
x - 2 - x - 3 = 3 \\
-5 = 3 \\
No real solution
\]

Alternative (contradicting) Approach:
Ran's solution: \( x = -2 \)

Reasoning:
We have to take into account that \( \sqrt{(x - 2)^2} = \sqrt{(2 - x)^2} \) and that \( \sqrt{(x + 3)^2} = \sqrt{(-x - 3)^2} \).

Though, we have to consider 4 possible cases:
Either \( (x - 2) - (x + 3) = 3 \), or \( (x - 2) - (-x - 3) = 3 \), or \( (2 - x) - (x + 3) = 3 \), or \( (2 - x) - (-x - 3) = 3 \)

Solving any of these equations and checking whether their solutions solve the original one, yields that only \( (2 - x) - (x + 3) = 3 \) fulfils this condition. Its solution is \( x = -2 \), so this is the solution of the original equation.

Data analysis
The research follows a qualitative paradigm. Accordingly, the data was analysed inductively and the categories stemmed from content analysis. First, the group decision was coded according to correctness of the resolution outcome. Then, the first group
reaction to the alternative approach was coded. Afterwards we coded the type of group work, frequency of participation, and finally the point of ending the group session.

**FINDINGS**

As we assumed, all the students solved Task 1 the same as the anticipated student solution detailed above, while in Task 3 most of the students solved it as the anticipated solution. There was one pair who solved it differently. For this pair the researcher presented first the anticipated solution, and after they agreed with it, she presented the alternative contradicting approach.

With respect to the group dynamics, for each type of group we identified four main characteristics in the process of reaching a conflict resolution: three specific to it and one common to both.

The main characteristics of the dynamics of groups of four:

- The first reaction of the group to the alternative contradicting approach was denying or rejecting it
  - Dorit (reacts to the alternative solution of Task 1): It simply looks longer because you have first to look for the slope of each graph, and then the intersection points and then to sketch it, and then [to find] when they are equal…it looks very long.
  - Alon (reacts to the alternative solution of Task 3): What?! It's not right! It's wrong!

- The group work was characterised by "throwing in the air" suggestions sporadically by the group members

- One member of the group participated in the group work to a larger extent than the others. S/he seemed to be the 'leader' of the group: raised more ideas and was asked mathematical questions by the other members

Main characteristics of the dynamics of groups of two:

- The first reaction of the group to the alternative contradicting approach was accepting it / justifying it / checking why it is true
  - Hila (reacts to the alternative solution Task 1): It looks as if the 6 doesn't matter.
  - Alon (to Hila): So there is a mistake at our solution.
  - Ido (during the interview): In four, the pressure of the group is more powerful than the contradicting statement.

- The work was characterised by engagement in a meaningful dialog between the two students. The conversation dealt with broad mathematical concepts and ideas

- Both students had a similar rate of participation in the dialog

The common characteristic that was identified for both types of groups is connected to the end of the session. The groups decided to end their work right after one of the members agreed with the alternative solution. Although it seemed that there were explanations to be offered and questions to be asked, all of the group members agreed.
that at this stage the session should end. It seemed that some of them did not understand the reason for the fault in their solution.

With respect to individual processes, the interviews with the students revealed four main reflections they shared with the researcher:

- Students had much to say about the difference between working in a pair and working in a group of four:
  - Working in pair was much more demanding for them - they felt more active and responsible for the process. In a group of four most of them felt passive and relied on others.
  - Working in a pair involved deep thinking, while in a group of four it seemed superficial work.
  - Within a pair they felt the process was more fruitful for them.

Following are excerpts from the interviews which point to the above differences:

  Benny: In group of four the work is more social, that's why the work was less deep and demanded less thinking. You have to activate less thinking, because you know there are other active people who think on the same problem. In four there are more people, so I felt I can count on them. In pairs – either she is right or me. In pairs you have to make bigger efforts. I worked with one mate, that's why it demanded more thinking - there is what she says and what I say, so you know that if she says the opposite, one of us is wrong.

  Dorit: In pairs everyone thought more deeply. You have to handle the problem more by yourself. There is much work on the individual. There is much more responsibility on every one.

  Nili: In four you reach an agreement faster. In pairs it is much harder, because there is none who understands me, and it is slower then in four.

- The students seemed to be bothered by the contradiction. They expressed their willingness to ask mathematical questions regarding the tasks.

  Researcher (to Alon): Do you have questions?
  Alon: Yes. Why is our solution wrong?
  Researcher (to Hila): Are you satisfied with the resolution you suggested?
  Hila: I don't feel totally satisfied with it, because I don't know how it is organized. I don't understand how my way goes with the way you showed us.

- In most cases, regardless of the group size, the students agreed that the alternative/contradicting approach was the correct one. They were even able to explain why. However, 7 of the 8 students were not able to find the flaw in their initial solution.

- Regardless of the group size in which the students worked, at the end of the study they all expressed scepticism regarding general mathematics tools. Their confidence in mathematics was weakened.
DISCUSSION

As seen by the group dynamics and by the interviews, there are some differences between the processes of groups of four and pairs.

A decision of a group of four seems to be more powerful than a decision of a pair. Students in a group of four felt empowered by the group decision, and therefore rejected the alternative approach, despite its correctness. The same students reacted differently while working in pairs – they hesitated and checked the alternative approach carefully.

Another difference concerns the rate of participation of the students. In pairs the rate of participation was similar to both members, while in groups of four one member took the 'leadership', and the other members counted on him/her. This could be explained by the tendency of individuals to reduce their work effort as groups increase in size, a phenomenon called *Social loafing* (North, Linley & Hargreaves, 2000; Latane, Williams & Harkins, 1979).

A third difference concerns the type of group work. While pairs conducted a dialog, groups of four did not demonstrate an efficient group conversation. We attribute this finding also to the above tendency of *social loafing* in big groups. Being one of a pair forces the individual to take more responsibility than being one of four, and therefore to react to her/his mate's questions. While in four a question did not address a particular member, in a pair it did. Ido articulated this idea nicely: “In contrary to the group, in a pair there is what she says and what I say”.

The common characteristic of group dynamics relates to the end point of the session. In both group sizes the students ended the session as soon as one of them recognized s/he understands the alternative solution. This finding supports the claim that experiencing a cognitive conflict is not enough for constructing new knowledge structures. The students ended up the group work without fully understanding the mathematical ideas beyond the task. A direct teaching session is needed in order to complete the learning process. We indeed conducted a meeting with the 8 students, by which we focused on the roots of the faults in the students solutions. This lesson was meaningful for the students and helped them to resolve the conflict they had regarding these two tasks.

References


