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AUTHOR	Jones, Gail
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ABSTRACT

This study compared the effects of cooperative learning groups to traditional instruction in remediating students' misconceptions about temperature. Students from grades 3, 4, and 5 in two rural elementary schools participated in the study. Students completed a pretest, a cognitive conflict laboratory activity and a posttest that measured qualitative and quantitative aspects of their understanding of temperature. The control group completed the activity in traditional dyads and the experimental group completed the activity in cooperative learning groups composed of four students. The experimental group was given laboratory worksheets that asked the group to first solve a qualitative problem and the quantitative problems that referred to the same type of measurement to create cognitive conflict between the two representational systems related to temperature. Students were asked to compare their answers on the two problems. If their answers conflicted, they were told to decide which answer was correct and to carry out an experiment to prove their answer. No directions were given for control group students on the predictions or results, but they were asked to answer the questions on the laboratory activity sheet together. The results indicated that the conflict training was effective in changing students' concepts of temperature, but the cooperative learning group were no more effective than the traditional dyads. (YP)

COGNITIVE CONFLICT AND COOPERATIVE LEARNING

Gail Jones
Assistant Professor
University of North Carolina- Chapel Hill
Chapel Hill, North Carolina 27599-3500

Abstract

This study compared the effects of cooperative learning groups to traditional instruction in moving students through misconceptions about temperature to a more acceptable cognitive framework. Students from grades 3, 4 and 5 in two rural elementary schools participated in the study. Students completed a pretest, a cognitive conflict laboratory activity and a posttest that measured qualitative and quantitative aspects of their understanding of temperature (Stavy & Berkovitz, 1980). The control group completed the activity in traditional dyads and the experimental group completed the activity in cooperative learning groups composed of four students. The results indicated that the conflict training was effective in changing students' concepts of temperature, but the cooperative learning groups were no more effective than the traditional dyads.

Introduction

Vygotski (1962) identified two sources of knowledge in an individual. One source of knowledge comes from interaction with the environment and has been called "gut" knowledge, intuitive knowledge, or naive knowledge. This type of knowledge is influenced by peer interactions, language and experience as the individual attempts to make sense of the environment (West & Pines, 1985). The other source of knowledge is the type derived from formal instruction that occurs in classrooms. West and Pines (1985) suggest that cognitive growth occurs as students try to integrate and make sense of these two types of knowledge. When these two types of knowledge are in opposition, cognitive conflict occurs. For example, most young people start out thinking that the world is flat, by observing the appearance and disappearance of the sun and moon. It is only by formal instruction that our conception of the earth is altered from flat to round. Conceptual resolution or assimilation occurs as new knowledge is incorporated into a new concept. "Conceptual change views... emphasize the transformations of conceptions in the process of learning. New ideas are not merely added to old ones; they interact with them, sometimes requiring the alteration of both." (Strike & Posner, 1985, p. 215).

Research has shown that misconceptions are resistant to change and students must experience some dissatisfaction or anomaly that challenges their prior understanding (Clough, Driver & Wood-Robinson, 1987). Most teachers have had experience with students who can demonstrate formal understanding of complex phenomena on written tests, but when asked to explain their answers in depth, are unable to defend their position. These students may have accepted the formal school instruction without making the accompanying conceptual change.

Students often hold a number of scientific misconceptions, or alternative frameworks, that they have developed in an attempt to explain the world around them (Novak, 1987). These misconceptions interfere with cognitive growth and are very resistant to change. Considerable research has gone into identifying misconceptions, but little has been done to develop instructional strategies to reduce or remove the deleterious effects of misconceptions (Novak, 1987).

Cognitive conflict training has been shown to be effective in altering misconceptions in experimental or quasi-experimental situations, especially for students in transition states between two cognitive structures (Stavy & Berkovitz, 1980). This technique involves exposing the misconception through an "exposing event," creating conceptual conflict, and encouraging cognitive accommodation (Nussbaum & Novick, 1982). Posner, Strike, Hewson, and Gertzog (1982) have suggested four prerequisites for conceptual change:

1. Students must experience dissatisfaction with their current conceptions.
2. Students must develop a minimal understanding of the concept.
3. The concept must be plausible.
4. Students must see the concept as useful in several different situations.

Stavy and Berkovitz (1980) identified a science misconception that 8-11 year old students have about the qualitative and quantitative intensitivity of temperature. For a qualitative representation, young students believe that a glass of warm water poured into another glass of warm water will result in very warm water. In addition, many students believe that a glass half full of 40° F water poured into a half full glass of 40° F water results in 80° F water. Stavy and Berkovitz reported that the quantitative temperature tasks were much more difficult for children to solve than qualitative ones. Stavy and Berkovitz have further identified a developmental stage in which students understand the qualitative temperature task (that warm water plus warm water equals warm water), but are unable to understand the quantitative representation of temperature. These students will state that 10° F water plus 10° F water results in 20° F water. When confronted with this apparent conflict, older children will apply their correct qualitative knowledge of the situation and translate it to the numerical system.

Stavy and Berkovitz (1980) used short-term, individual and traditional classroom treatments to create cognitive conflict in their study of the development of temperature concepts. They reported that the traditional treatment was more helpful than the individual training. However, the population size was relatively small (N=77), and their study did not consider the role that peer interactions play in promoting cognitive growth. Piaget's work (1926) first emphasized the importance of peer interaction on cognition. Sharing of differing perspectives with another individual has been considered a means of creating cognitive conflict and conceptual change (Cannella, 1988).

One suggested reason for the effectiveness of peer interaction is that peers are more likely to operate within one another's proximal zone of development (Vygotsky, 1962, 1978). The zone of proximal development is the distance between an individual's development and the group's potential problem-solving level. Peer interaction is effective in promoting cognitive growth, because children working within one another's proximal zones of development are able to model group behaviors more advanced than those they could perform alone as individuals (Slavin, 1987). Piagetian and Vigotskian theories support the need for reciprocity, with peers mutually respecting and attending to the opinions of others (Cannella, 1988).

The verbalization component of peer interaction may prove critical for cognitive development. Driver (1986) suggested that the exchange of ideas in small groups may promote the development of complex conceptions. The Generative Learning Model proposed by Osborne and Wittrock (1983) suggests that for conceptual change to occur, teachers must ascertain students' ideas prior to instruction and facilitate the exchange of views and challenge students to compare ideas. Durling and Schick (1976) also reported that college students who vocalized during problem-solving were more successful in concept attainment than were students who did not vocalize. In addition, overt verbalization has been shown to increase the problem-solving abilities of learning-disabled children (Wilder, Draper & Donnelly, 1984) and to increase self-control in hyperactive children (Palkes, Stewart & Kahana, 1968).

Cooperative learning is a term applied to several strategies developed by Slavin (1980), and extended by Johnson and Johnson (1987). The essential element underlying cooperative learning techniques is that students work together under specified conditions in a cooperative group to attain certain educational objectives. The strategies have been developed and tested in a large number of settings and have been used in most curricular areas.

Cooperative learning has been shown to be more effective than traditional instruction in promoting student achievement (Humphreys, Johnson & Johnson, 1982; Sherman & Thomas, 1986). Lew, Mesch, Johnson and Johnson (1986) reported that cooperative learning strategies promoted positive relationships and higher achievement for mainstreamed socially and academically handicapped students. Cooperative learning has also been associated with higher student attitudes towards learning (Tjosvold & Santamaria, 1978) and towards school (Slavin, 1977, 1980).

The purpose of this research study was to repeat Stavy and Berkovitz's (1980) study of children's development of concepts of temperature intensitivity and to compare the effectiveness of cooperative learning groups and traditional learning dyads in moving students through a cognitive conflict and altering students' misconceptions about temperature to a more accepted conceptual understanding. Stavy and Berkovitz (1980) have already shown that sort-term conflict training can be effective in promoting cognitive growth. Cooperative learning has also been shown to result in higher achievement and is commonly used by elementary and secondary teachers. The goal of this study was to determine if cooperative learning would enhance the cognitive conflict treatment if administered in a typical classroom setting. It was hypothesized that students in the cooperative (experimental) group would make greater gains in conceptual change as measured by the posttests than those students who worked in traditional dyads.

Method

Subjects

This study was conducted in two large elementary schools in a rural southeastern school system. All the teachers in the study were volunteers who had completed several inservice training programs on cooperative learning. Total training time was eight hours. During the training, teachers were taught principles of cooperative learning, how cooperative learning differs from traditional learning, three commonly used cooperative techniques and how to teach cooperative social skills to students. Two months after the inservice training, teachers were surveyed to see how successful they had been in using cooperative learning techniques in their classes. The classes of those teachers who indicated they had successfully used cooperative learning strategies at least once a week were selected to participate in the study as part of the cooperative learning (experimental) group. Teachers who indicated that they chose not to use cooperative learning were selected to participate as part of the traditional (control group). Five classes of third graders, four classes each of fourth graders and four classes of fifth graders participated in the study. Overall, there were 108 students in the experimental group and 129 students in the control group.

Procedure

The experimental and control groups were given a slightly modified pretest, laboratory activity and posttest developed by Stavy and Berkovitz (1980). The study did not begin until five months after the inservice training to ensure that teachers and students in the experimental group had ample opportunities to utilize cooperative learning. Prior to the study, all students were given instruction on using a thermometer to measure water temperature. The pretest and laboratory activity were given on two separate consecutive weeks.

Pretest

The pretest (Figure 1) was given to all students to determine conceptual understanding of temperature intensitivity. Students who answered at least 50% of the questions of each of three subtests correctly were considered to have an acceptable understanding. The subtests measured quantitative intensitivity, qualitative intermediate intensitivity and quantitative intermediate intensitivity.

Laboratory Activity

The students in the cooperative learning (experimental) classes completed the laboratory activity in their cooperative learning groups consisting of four students. Pretest results revealed that at least three of the four members in each group held a temperature misconception. Each group was given laboratory worksheets (Figure 2) that asked the group to first solve a qualitative problem and then quantitative problems that referred to the same type of measurement. The laboratory activity was developed by Stavy and Berkovitz (1980) to create cognitive conflict between the two representational systems related to temperature: the qualitative- verbal one and the quantitative- numerical one. Next students were asked to compare their answers on the qualitative and quantitative problems. If their answers conflicted, they were told to decide which answer was correct and then to carry out an experiment to prove their answer. The groups were given thermometers, beakers and water, and instructions for measuring water temperature. The students were told to discuss what they predicted would happen with what actually happened. They were asked to explain any discrepancies between the predicted results and the actual results with their cooperative teammates. Each individual student was held accountable for answering the questions on his or her own activity sheet.

The students in the control classes were given the same apparatus and instructions, but were directed to work with traditional lab partners. No more than one member of each pair was identified as not having the misconception, in some cases both members of the dyad had misconceptions as measured by the pretest. No directions were given for students to discuss their predictions or results, but they were asked to answer the questions on the lab activity sheet together. To ensure uniformity of implementation, all laboratory activities were directed by the same pair of investigators. Students in both the control and experimental treatments took about fifty minutes to complete the laboratory activity.

Posttest

Both the cooperative and traditional learning classes were given posttests three weeks following the completion of the lab activity. Posttest results were compared for the experimental and cooperative groups using chi square.

Results

The percentages of children in the cooperative and control groups who were successful in each type of test are shown in Table 1. The pretest results revealed no significant differences between the cooperative and control group. The pretest data were similar to the results obtained by Stavy and Berkovitz (1980) and indicate that most children in grades 3, 4 and 5 understand qualitative temperature intensitivity but are not as successful in understanding quantitative temperature concepts.

Chi square analysis of posttest results for cooperative and traditional grouping indicated no significant difference for the quantitative intensitivity (X^2=.13, df=1, ns), intermediate qualitative (X^2=.16, df=1, ns) and intermediate quantitative (X^2=.43, df=1, ns). Although students did grow in their conceptual understanding of temperature intensitivity for quantitative and qualitative intermediate concepts, the traditional groupings grew as much as those in the cooperative learning groups.

Discussion

The results of this study indicate that cooperative learning groups composed of four students were no more effective in training by conflict than were traditional dyad groupings. The conflict training activity was effective in making students aware of their differences between the qualitative intuitive representative system and their quantitative-numerical system. However, students from both groups moved from holding a misconception to a better understanding of quantitative and qualitative temperature intensitivity. This supports Stavy and Berkovitz's (1980) results that short-term cognitive conflict training can promote cognitive growth.

There is considerable research to support the effectiveness of cooperative learning strategies. Although the results of the present study did not support other reported results that cooperative learning is more effective in promoting achievement (DeVries, Edwards, &

Slavin, 1978; Okebukola & Ogunniyi, 1984; Sharan, 1984), the present results do support Slavin's (1983) claim that cooperative learning techniques are as least as effective as traditional learning modes. Sherman (1988) and Rogan (1988) also failed to find any significant science achievement gains in the use of a cooperative group investigation model when compared to a traditional model.

It was hypothesized prior to beginning the study that the verbalization and sharing of ideas that occurs within the cooperative groups would stimulate cognitive growth. The students in the cooperative group did appear to talk more; however, it was observed that some groups had one or more dominating individuals who held misconceptions and would assert their views and attempt to convince the other members of the group to adopt their perspective. Students often cling to misconceptions and resist efforts to change them. It is possible that the social structure of the cooperative groups made it difficult for less outspoken students (in conflict) to verbalize and change their misconceptions. Further research may unravel the social dynamics within cooperative learning groups that impact on cognitive conflict strategies.

Significance

The way learners construct meaning of the world around them is of interest to most educators. When students construct inaccurate concepts of natural phenomena, an understanding of the process becomes even more critical. There are numerous, widely held misconceptions in science, including ideas about cellular structure, photosynthesis, genetics, growth and development, and physics. The tenacious nature of science misconceptions makes it difficult for educators to successfully implement curricula and promote cognitive growth. Little has been done to provide teachers with reasonable and effective strategies to alter misconceptions.

Confrontation strategies such as the laboratory activity used in this research may prove to be an efficient and effective way for teachers to promote cognitive growth. Trowbridge and Mintzes (1988) suggested that teachers should provide students with opportunities to discuss and debate alternative explanations of phenomena. Students should then be provided with a culminating activity to enable students to reconstruct meanings and subsume new ideas into a conceptual framework that is closer to the accepted scientific framework. Although this study did not find the cooperative learning groups to be more effective than traditional dyads when used in cognitive conflict training, it was as least as effective.

Suggestions for Further Study

Further research is needed to unravel the complexities of cooperative learning strategies. Further studies can examine the role of peer verbalization on cognitive development. Additional studies can provide data on the role that cognitive conflict plays in promoting cognitive growth, the interaction of cognitive conflict and peer interaction, misconceptions about intensitivity of temperature, and how peer interactions can alter students' misconceptions. It is hoped that eventually this line of research will lead to the development of a series of strategies teachers can easily and effectively use in their classrooms to alter misconceptions and promote cognitive growth.

References

Cannella, G. (1988, April). The nature of dyadic social interaction producing cognitive growth in young children. Paper presented at meeting of the American Educational Research Association, New Orleans, LA.

Clough, E., Driver, R., Wood-Robinson, C. (1987). How do children's scientific ideas change over time? Dec, 255-267.

DeVries, D., Edwards, K., & Slavin, R. (1978). Biracial learning teams and race relations in the classroom: Four field studies on TGT. Journal of Educational Psychology, 70, 356-362.

Driver, R. (1987). Promoting conceptual change in classroom settings: The experience of the children's learning in science project. In: Novack, J. (Ed.), Proceedings of the 2nd International Seminar "Misconceptions and Educational Strategies in Science and Mathematics." (Vol. I., 26-31) Ithaca, Cornell University.

Durling, R., & Schick, C. (1976). Concept attainment by pairs and individuals as a function of vocalization. Journal of Educational Psychology, 68(1), 83-91.

Humphreys, B., Johnson, R., & Johnson, D. (1982). Effects of cooperative, competitive and individualistic learning on students' achievment in science class. Journal of Research in Science Teaching, 19(5), 351-356.

Johnson, D. & Johnson, R. (1987). Learning together and alone. Second Edition, Englewood Heights, NJ: Prentice-Hall.

Lew, M., Mesch, D., Johnson, D., & Johnson, R. (1986). Components of cooperative learning: Effects of collaborative skills and academic group contingencies on achievement and mainstreaming. Contemporary Educational Psychology, 11, 229-239.

Novak, J. (ed.) (1987). Proceedings of the second international seminar. Misconceptions and educational strategies in science and mathematics. Ithaca, NY: Cornell University.

Nussbaum, J., & Novick, S. (1982). Alternative frameworks, conceptual conflict and accommodation: Toward a principled teaching strategy. Instructional Science, 11, 183-200.

Okebukola, P., & Ogunniyi, M. (1984). Cooperative, competitive, and individualistic laboratory interaction patterns: Effects on students' achievment and acquisition of practical skills. Journal of Research in Science Teaching, 21(9), 875-884.

Osborne, R., & Wittrock, M. (1983). Learning science: A generative process. Science Education, 67(4), 489-508.

Palkes, H., Stewart, M., & Kahana, B., (1968). Porteus maze performance of hyperactive boys after training in self-directed verbal commands. Child Development, 39, 817-826.

Piaget, J. (1926). The language and thought of the child. New York: Harcourt Brace.

Posner, G., Strike, K., Hewson, P., & Gertzog, W. (1982). Accomodation of a scientific conception: Toward a theory of conceptual change. Science Education, 66(2), 211-227.

Rogan, J. (1988). Development of a conceptual framework of heat. Science Education, 72(1), 103-113.

Sharan, S. (1984). Cooperative learning in the classroom: Research in desegragated schools. Hillsdale, NJ: Lawrence Erlbaum.

Sherman, L. (1988). A comparative study of cooperative and competitive achievement in two secondary biology classrooms: The group investigation model versus an individually competitive goal structure. Journal of Research in Science Teaching, 26(1), 55-64.

Sherman, L., & Thomas, M. (1986). Mathematics achievement in cooperative versus individualistic goal-structured high school classrooms. Journal of Educational Research, 79, 169-172.

Slavin, R. (1977). A student team approach to teaching adolescents with special emotional and behavioral needs. Psychology in the Schools, 14(1), 77-84.

Slavin, R. (1980). Cooperative learning. Review of Educational Research, 50(2), 315-342.

Slavin, R. (1983). When does cooperative learning increase student achievment? Psychological Bulletin, 93, 429-445.

Slavin, R. (1987). Developmental and motivational perspectives on cooperative learning: A reconciliation. Child Development, 58, 1161-1167.

Stavy, R., & Berkovitz,B. (1980). Cognitive conflict as a basis for teaching quantitative aspects of the concept of temperature. Science Education, 64(5), 679-692.

Strike, K., & Posner, G. (1985). A conceptual change view of learning and understanding. In L. West & A. Pines (Eds), Cognitive structure and conceptual change (pp.211-231). NY: Academic Press

Tjosvold, D., & Santamaria, P. (1978). Effects of cooperation and teacher support on student attitudes toward decision making in the elementary classroom. Journal of Research in Science Teaching, 15(5), 381-385.

Trowbridge, J., & Mintzes, J. (1988). Alternative conceptions in animal classification: A cross-age study. Journal of Research in Science Teaching, 25(7), 547-571.

Vygotsky, L. (1962). Thought and language. Cambridge, MA: MIT Press.

Vygotsky, L. (1978). Mind and society. Cambridge, MA: Harvard University Press.

West, L., & Pines, A. (Eds) (1985). Cognitive structure and conceptual change. NY: Academic Press.

Wilder,L., Draper, T., & Donnelly, C. (1984). Overt and covert verbalization in normal and learning disabled children's problem solving. Perceptual and Motor Skills, 58, 976-978.

Table 1

Percent Children Successfully Solving Temperature Concepts

		Intensitivity		
Group	Test	Quantitative	Intermediate Qualitative	Intermediate Quantitative
Cooperative (Groups of 4) N=108	Pre	9.3	98.1	4.6
	Post	21.2	99.1	2.8
Control (Groups of 2) N=129	Pre	9.3	93.8	2.3
	Post	19.4	98.4	1.6

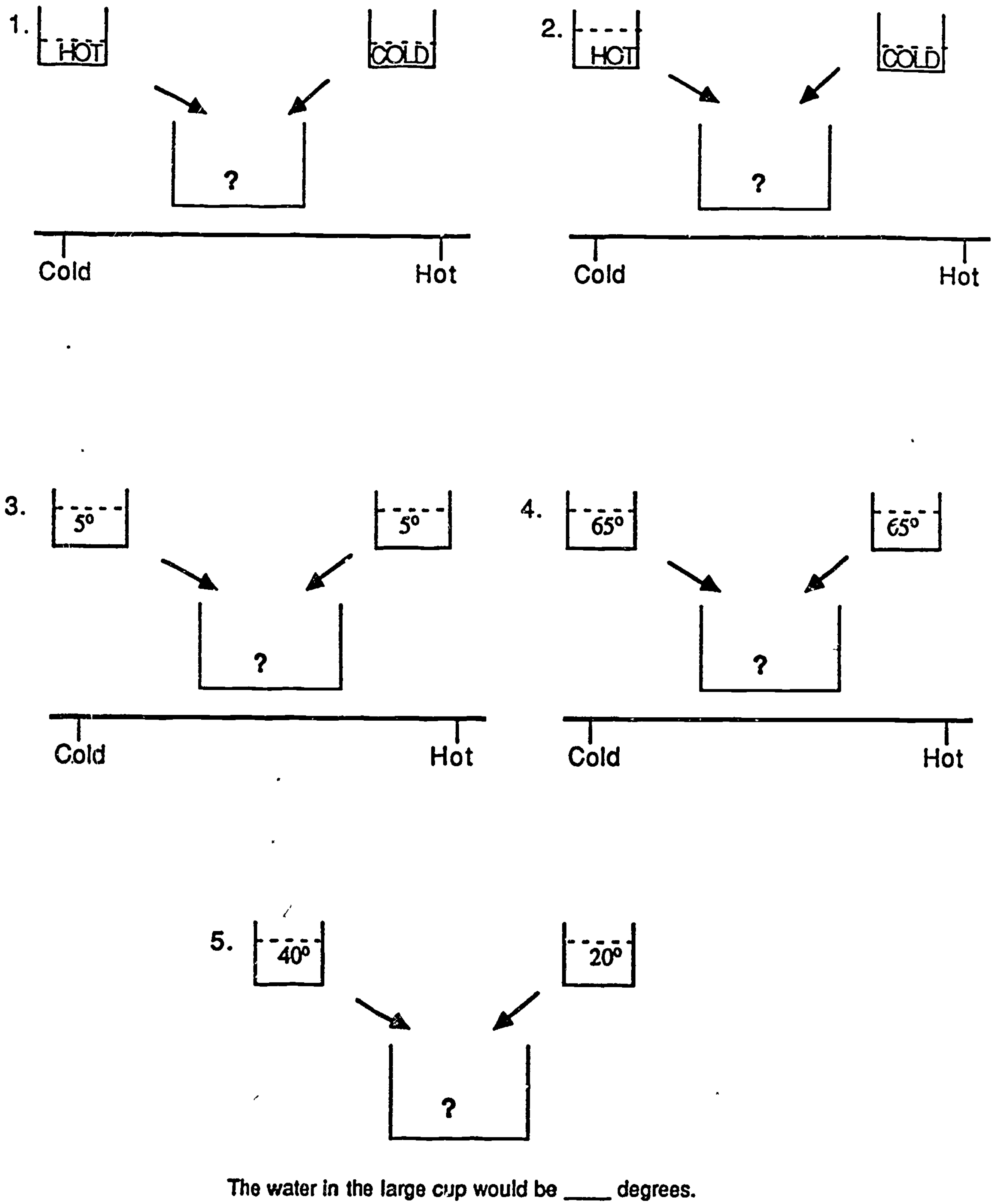


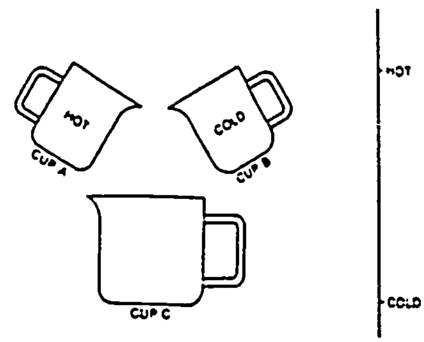
Figure1. Pretest.
Adapted from "Cognitive Conflict as a Basis for Teaching Quantitive Aspects of the Concept of Temperature" by R. Stavy and B. Berkovitz, 1980, Science Education, 64(5), 679-692.

Question 1
On the table there are three cups. In cup A, there is hot water, in cup B there is cold water, and cup C which is larger than cups A and B is empty.

Mother poured the hot water from cup A and the cold water from cup B into cup C and mixed them.

What do you think will be the hotness of the water in cup C?

Mark on the temperature line the point which corresponds to the hotness of the water in cup C.



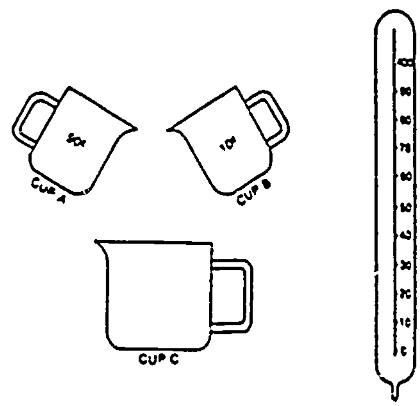
Question 2
On the table, there are three cups. One of them, Cup C is empty.
The temperature of the water in cup A is 90^{o}.

The temperature of the water in cup B is 10^{o}.

Mother poured the water from the two cups into cup C and mixed them.

What do you think is the temperature of the water in cup C?

Mark this temperature on the thermometer.



Question 3
How are the first and second questions similar and how are they different?

Are your answers to these questions the same or not?

Line up your temperature line (from question 1) up next to your thermometer (on question 2).
Compare the two temperatures.

What do you think are the correct answers to the first and second question?

Question 4
Carry out a similar experiment of mixing cold water and hot water. How will you do it?

Fill one cup with cold water and measure its temperature.

Fill a second cup with an equal amount of hot water and measure its temperature.

How is this experiment similar to the first, second and third questions?

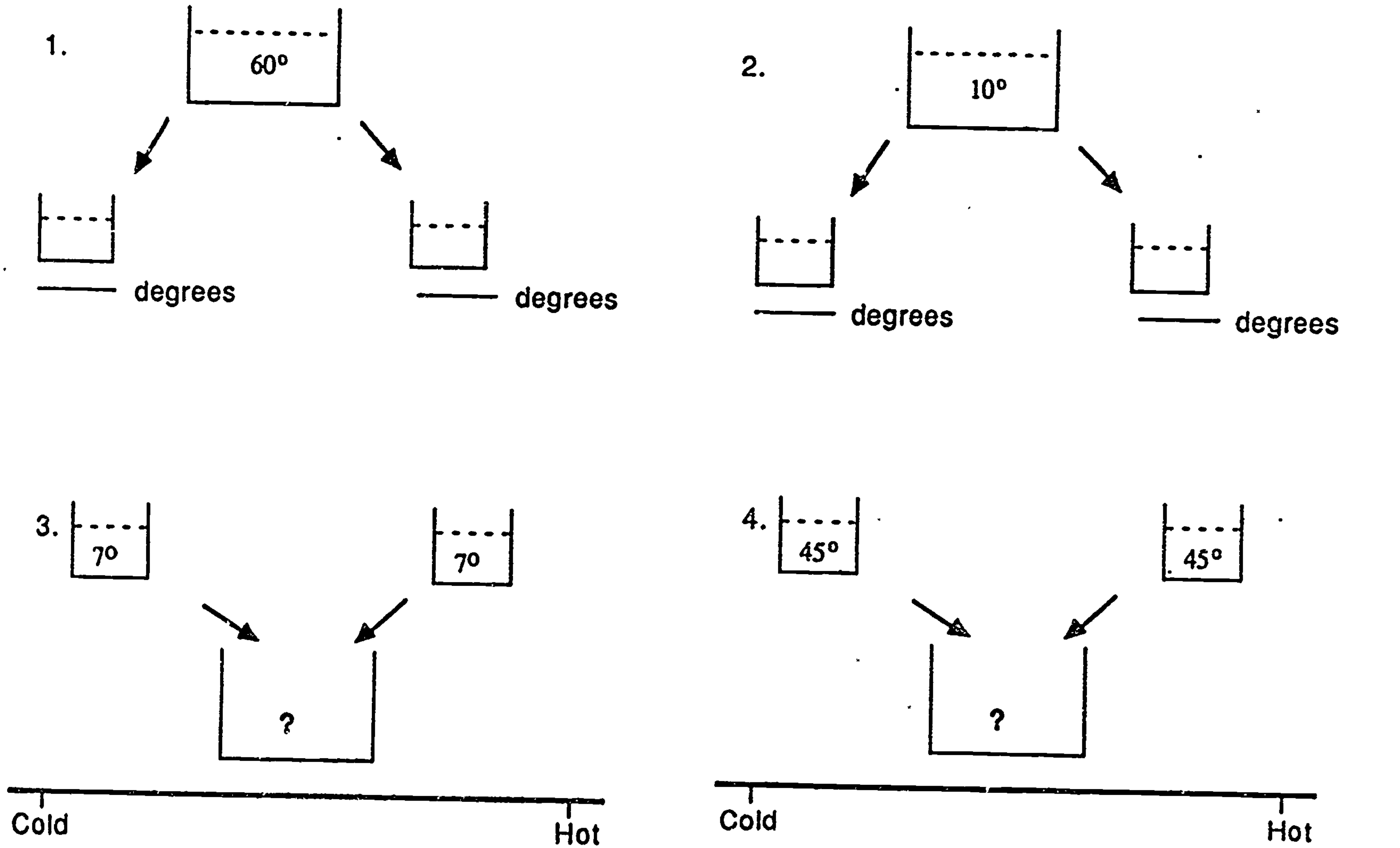


Figure 3. Posttest.
Adapted from "Cognitive Conflict as a Basis for Teaching Quantitive Aspects of the Concept of Temperature" by R. Stavy and B. Berkovitz, 1980, Science Education, 64(5), 679-692.