

Communication: Equity Pedagogy in the Mathematics Classroom

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Abstract

This research was to investigate the impact of communication in the mathematics classroom. The investigation was in a form of a game after which participants were provided with an open-ended question. Participants' written open-ended responses were analyzed. The results show that participants felt helpless, challenged, lost, defeated, frustrated, and extremely confused when they were not allowed to communicate. However, they felt encouraged, engaged, empowered, and emancipated when they were allowed to collaborate and play as a team. The results make a very strong case for the use of effective communication as a tool for equity pedagogy in the mathematics classroom.

Keywords: Emancipatory Pedagogy, Empowerment, Equity Pedagogy, Mathematical Language, Real-world connections

Introduction

Within the field of mathematics education, many researchers and teacher educators see a particularly urgent need to improve methods and curriculum to accommodate students with different backgrounds and experiences (Boaler, 2002; Holloway, 2004; Rousseau & Tate, 2003). This urgency comes from recognizing that many students have often failed to reach higher levels of mathematics achievement, interest, or confidence (Gamoran, 2001; Holloway, 2004; Meier, 2003; Moses & Cobb, 2001; Schoenfeld, 2002). According to the *Principles and Standards for School Mathematics* (NCTM, 2000), mathematics educators must pursue equity in the mathematics classroom by challenging the pervasive notion that only some students are capable of learning mathematics at a high level.

Purpose of the Study

The NCTM equity principle encourages teachers to have high expectations and offer worthwhile opportunities for all students. Van De Walle (2001) argues that unless students are challenged, many of them might find it difficult to develop the confidence or ability to learn to do mathematics. The NCTM (2000) makes a strong case that effective communication enables teachers to create supporting and challenging environments that actively engage students in a rich classroom conversational dialogue, which deepens their mathematical understanding. Cobb, Wood, and Yackel (1994) have stated that because mathematics is so often conveyed in symbols, communication about mathematics ideas is not always recognized as an important part of mathematics education. Thus, the research reported here describes in-service teachers' perspectives about communication, equity pedagogy, and the importance of encouraging students to communicate mathematically to support equity pedagogy.

Theoretical Framework

Equity Pedagogy

According to Lipman (2004), equity means "equitable distribution of material and human resources, intellectually challenging curriculum, educational experiences that build on students' cultures, languages, home experiences, and identities; and pedagogies that prepare students to engage in critical thought and democratic society" (p. 3). Banks (2003) have defined equity pedagogy as teaching strategies that help students attain the knowledge, skills, and attitudes needed to function effectively within, and help create and perpetuate a just, humane, and democratic society. The NCTM (2000) gives greater prominence to equity.

For example, it names equity as one of its guiding principles, and states, “Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students” (p. 12).

Communication

The role of communication in mathematics learning has been identified as a key process in building students’ mathematical understanding (Macgregor & Price, 1999; Manouchehri & Enderson, 1999). According to Kersaint, Thompson, and Petkova (2009), “language is the primary vehicle for learning, instruction, and overall intellectual development. It is not only a means for communicating information, it is also a vehicle for deepening their understanding of important ideas” (p. 46). Green (2005) asserts that mathematics language can be as challenging as a foreign language because it involves both the language of words (also called the conversational language) and the language of symbols. The NCTM (2000) points out that conversational language makes it possible to teach children important formal mathematics terminology. Through the facilitation of mathematical discussions by teachers, students actively participate in making conjectures, provide clear explanations (Pierson, Maldonado, & Pierson, 2008), and demonstrate conceptual understanding in mathematics. Students’ mathematical reasoning and problem solving skills are enhanced when they verbalize their thought processes.

Methodology

Participants and Instrumentation

Participants in this study are teachers involved in a professional development program during the 2013-2014 academic years. All 15 participants are certified or licensed teachers, and are credentialed to teach in any of grades one through eight; some also are credentialed to teach kindergarten. The context of the study is a school district wide Professional Development Program for teachers in elementary, intermediate, and middle schools. The instrument is a game of squares. Five squares with dimensions 5 inches by 5 inches were made on a construction paper. Each square was cut into three pieces as shown in the figure below (see fig. 1).

All fifteen pieces were then shuffled and placed in 5 envelopes, with 3 pieces in each envelope ensuring that no three pieces would form a square. In all, 3 sets of 15 pieces were made. Each participant was given an envelope that contains three pieces of geometrical shapes (see fig. 2).

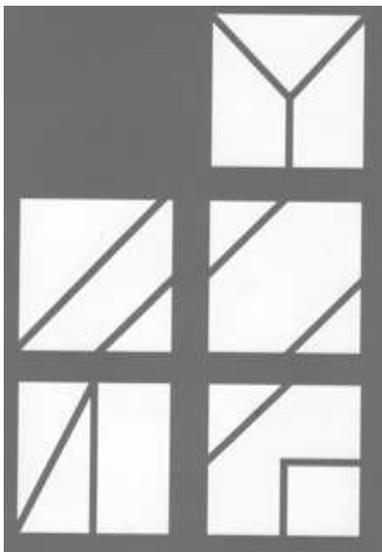


Fig. 1. Five squares from which the shapes were cut into three pieces each



Figure 2. Five of three pieces each of geometrical shapes provided to students

The rules of the game was provided to each participant as follows:

- No talking, tapping or any form of communication.
- You must have exactly three pieces at a time.
- You can give a piece to someone if you think it will help him/her.
- One can either accept or reject a piece from someone without talking.

- No folding of the pieces
- Everyone must create a square using 3 pieces for the game to be over.

Players are allowed to trade with each other until all five players at a table have each used their three pieces to make a square. The game is not over until all 15 participants have been able to form a square with their geometrical shapes. After 15 minutes, the researcher observed that the participants could not complete the game using the rules provided. They were then asked to replay the game but this time they were allowed to communicate using the following rules:

- Describe the shape you need to complete your square to your team without pointing.
- Describe the shape that a player need to the team.
- Use appropriate mathematical language in your description of the shape that is needed.

Data Analysis

After the game participants were given an open-ended question to which they provided responses. The question was as follows: “Explain how your students would have felt during the first part of the game; the second part of the game.” Participant written comments were analyzed by performing multiple readings of the data to construct conceptual categories that appeared to reflect participant perspectives (Bogdan & Biklen, 2007). The researcher repeatedly coded participants’ comments for general themes.

Findings

First Part of Game

For the first part of the game, students claim they felt helpless, challenged, lost, defeated, frustrated, and extremely confused. The following are how the participants described their feelings:

- I felt kind of helpless because I had a complete square in front of me; I was not sure how to make a square with the remaining pieces so I could not even help my other teammates. I also felt frustrated because I couldn’t talk or communicate with teammates.
- I had my square completed as did one or two other people, but others were not completed. I felt accomplished that I made a square, but confused that some of the others were unable to.
- I felt confused and frustrated. It was difficult to observe the shapes that other people needed to form a square, and not being able to talk also made it difficult. Collaboration was hard to do because we couldn’t communicate.

Second Part of Game

During the second part of the game, when participants were allowed to communicate, there was excitement and accomplishment. Four dominant themes, each described briefly below appeared across participants’ written comments: encouragement, engagement, empowerment, and emancipation. I call these four dominant themes, the Four E’s of equity pedagogy in the mathematics classroom.

Encouragement. In general, participants credited their ability to make their squares to the encouragement given to them by their teammates. Encouraging productive argumentation and justification in class discussions can lead to greater understanding. For example, three of the participants wrote the following statements:

- By making us talk, I feel like I am being encouraged to work, think, and talk together.
- I felt encouraged because I finally succeeded on this task. I still felt jealous that some of my teammates were creating their squares before me.
- After the second part of the game, I felt stupid for not realizing how to make a square for everyone. However, with communication, it was much easier to gather pieces, encourage and lend advice to other players.

Engagement. In their responses, participants tended to acknowledge their own responsibility in exerting effort and investing sufficient energy in engagement with their teammates. Participants not only feel encouraged to work, think, and talk together but also engaged in a very powerful mathematical task. They made such comments as:

- Being able to talk through my confusion helped the second time through playing of the game.
- Since we could talk to each other, we were able to tell each other what shapes they needed. We could also determine which shapes formed a square.
- I was so glad we were able to communicate because this helped tremendously

Empowerment. The participants claimed that during the first part of the game, they felt lost, defeated, and confused. However, during the second part of the game when they were allowed to collaborate and communicate with one another they had those “Aha” moments. Participants were filled with strength and empowerment after working out a problem from many different angles resulting in “Aha” moments. Their weaknesses and defeats can be spotted deflating; they felt empowered as they communicated and suggested ideas to their teammates. There was a feeling of a classroom environment in which it is safe to think aloud, challenge each other’s ideas and make mistakes. Thus, participants did put those into words as follows:

- When we finally completed the challenge and everyone had a completed square in front of them we had an “ahh ha” moment.
- I felt accomplished for figuring out the square finally, but kind of embarrassed for not getting it right sooner. I also felt helpful because I was able to talk with my teammates about which pieces they would need to complete their squares.

Emancipation. When the participants were allowed to communicate among themselves, they realize that communication as equity pedagogy will increase the possibility of emancipatory teaching for students from a variety of backgrounds and experiences. They made such comments as:

- I always feel reluctant to speak about mathematics because I not sure if my answers are right. But now I was able to talk to my teammates with ease.
- I like the way we were cooperating with each other during the second part of the game. I now see the importance of speaking up in any group discussions.

Closing Discussion

Somewhat contrary to what one might presume based on research regarding communication in mathematics education, the participants tended to be highly favorable to the use of communication in the mathematics classroom. The NCTM (1989, 2000) identified five clear sets of standards for teaching and assessing mathematics in all grade levels and provided mathematics educators with a solid base on which to build curriculum and instruction: (a) to understand and value mathematics, (b) to reason mathematically, (c) to communicate mathematics, (d) to solve problems, and (e) to make connections to real-world contexts and other academic subject areas.

In the mathematics classroom, when teacher-student relationships are fluid and equitable, students learn to collaborate, share tasks, accept criticism and alternate opinions, respect the decisions of others, construct their own knowledge, and become responsible for each other (Joseph, 2000). It is encouraging that these participants seemed to recognize the importance of communication as equity pedagogy. Although, they expressed frustration and confusion with a lack of collaboration at the beginning of the game, they felt accomplished, encouraged, and successful as they sufficiently apply teamwork ethic.

Four E’s of equity pedagogy

Encouragement. In the mathematics classroom, students should be encouraged to participate actively in mathematical activity and discussion, freely exchanging ideas and problem-solving strategies with their classmates and teachers, and taking intellectual risks and defending positions without fear of being incorrect. Although some students absorb mathematics through teacher presentations, all students learn better when they are actively engaged in the learning process. Students need to be active participants in their mathematics classes, discussing mathematics with the teacher and with each other, engaged in activities, which enhance their learning. They need to be prepared to propose strategies for solving problems, to provide explanations for why things work as they do, and to make conjectures for the consideration of their classmates. In order for them to do this, they must have a supportive classroom environment, which encourages diversity of thought. Teachers should establish a supportive classroom environment by making mathematical discussions a daily activity. These activities should encourage students to make suggestions and conjectures, and to propose strategies and explanations.

Engagement. It was evident from participants’ responses that through discussions students would demonstrate self-confidence as mathematical thinkers, believing that they can learn mathematics and can achieve high standards in mathematics, and accepting responsibility for their own learning. Participants tended to acknowledge their own responsibility in exerting effort and investing sufficient energy in engagement with their teammates. To help all students achieve mathematical self-confidence, teachers should believe themselves that *all* students when actively engaged can learn mathematics, even when their students are experiencing difficulties.

Empowerment. As students communicate mathematical thought they recognize the power that comes from understanding and doing mathematics. Teachers need to realize that by developing their students' ability to communicate with their teachers and classmates, they will be able to understand, formulate, and solve problems in a wide variety of situations. To help all students learn mathematics with understanding, it is the responsibility of teachers to introduce a variety of activities since different students make mathematics their own in different ways; some students learn best by constructing actual models, others learn best by hearing someone else talk about a mathematical idea, still others learn best by writing down the mathematical concepts for themselves or explaining them to others. Empowerment takes place when there is an encouraging culture of respect for mathematical thinking, which include real world applications as opposed to tricks and shortcuts.

Emancipation. Participants' perspectives and commitment to communication as equity pedagogy will increase the possibility of emancipatory teaching for students from a variety of backgrounds and experiences. Emancipatory pedagogy in the mathematics classroom is the process of teaching that aims to free the teacher and the student from the mental restrictions imposed by the mainstream culture on the way they perceive things. According De Lissovoy (2010) emancipatory pedagogy is defined as a form of self-directed education. The purpose is to guide learners towards autonomy and lifelong learning. In the mathematics classroom, it is important for teachers to convey to all students that they must all listen to their classmates respectfully and respond to their suggestions as members of a learning community. Students are often reluctant to speak about mathematics unless they are sure of their answers. They need to feel that their incorrect answers will be respected and are part of the learning process; they need to be sure that their answers will not simply be rejected and that they will not be humiliated. The teacher sets the tone of the classroom by ensuring that all who speak will be treated respectfully and their suggestions will be taken seriously. Emancipatory pedagogy takes place when students work cooperatively with other students on mathematical activities, actively sharing, listening, and reflecting during group discussions, and giving and receiving constructive criticism.

In conclusion, it seems that mathematics teachers and educators would benefit from a balanced approach of improving mathematics instruction with communication as equity pedagogy to influence high societal expectations for all students in mathematics, and reinforcing students' understanding of the importance of personal effort in learning mathematics, as well as communicating and collaborating with their peers. In order to do this, classrooms must be supportive of diversity of thought aimed at empowering individuals to be confident solvers and posers of mathematical problems embedded in social contexts and discourse.

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