



Teaching and Learning Geometry in Drama Based Instruction

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Abstract

This paper explains what drama-based instruction is and offers insights into the phases in drama-based instruction. Further, examples of drama-based lessons in geometry related to ring and circle, and altitude of a triangle together with the teacher and students perceptions related to the strengths and limitations of drama based instruction in geometry were presented.

Keywords: Drama, drama-based instruction, geometry, learning, perception, teaching

Introduction

A need to increase students' geometry achievement has been realized as students are not able to learn geometry as expected (e.g. NCTM, 2000; Ubuz & Üstün, 2003). The typical mathematics classroom with passive learners, rote learning, and single predetermined ways to solution do not seem to be responsive to the potential of today's children (Battista & Clement 1999; Garrity, 1998; Schoenfeld, 1983). Most formal school experience never gives students the opportunity to do anything with geometry except for lean back and listen. Students should, however, be given a chance to be involved in the learning process to learn meaningfully. In order for learning to be meaningful, learners should actively construct knowledge (Davis, Maher & Noddings, 1990). Learning is a very personal matter involving internalization of the concepts by the learner (Bruner, 1960; Dienes, 1964, 1967; Piaget, 1960). Further, as pointed out by Duatepe-Paksu and Ubuz (2009), the role of the teacher should be "to create an environment in which learners can construct, develop, and extend their mathematical view of the world" (p.272). That is, teacher should assist learning by creating a stimulating learning environment in which students are required to think critically the questions asked and investigate, discover and question the concepts learned. Therefore, drama based instruction proposes an alternative teaching method in geometry to provide meaningful learning engaging students actively in the learning processes, under the teacher's guidance.

This paper addresses many of the questions that might be asked by the teachers about drama based instruction: (1) What is the rationale for drama based instruction in geometry? (2) What are the phases of drama based instruction? (3) What resource materials for drama based instruction are available to the teacher in geometry, particularly for helping students to construct the meaning of altitude of a triangle, and ring and circle? and (4) What do students and teachers perceive as the strengths and limitations of drama based instruction in geometry?

Drama Based Instruction

Concurrent with constructivists' view (von Glasersfeld, 1989), drama based instruction is a specific teaching/learning environment allowing the participants to imagine, enact, and reflect upon their experiences, real or imagined under the guidance by a leader (Heinig, 1988). Engaging the students

in improvisational and process oriented experiences allow them to integrate mental and physical activities. The term improvisation is the spontaneous use of movement and speech to create a character or an object in a particular situation (Gallagher, 1997). Acting or playing spontaneously in experiential situation is not end itself but a means of exploring different concepts and behaviors. Namely, participants perform crudely as they do not need to act as professional actors or actress, as the success of the activity is not measured by the level of theatrical skill (Kelner, 1993).

Drama based instruction provides experiential learning environment (Rogers, 1983) in which students construct their own knowledge by means of their experiences out-of- school rather than imitating what has been taught (Bolton, 1986). In other words, "learning by doing" (Dewey, 1938) can be reckoned as the roots of drama based instruction. The climate of acceptance, psychological freedom and open communication allow students to accept different ideas, behaviors, feelings, values, and even mistakes of them. By this way, more tolerant understanding of others and more effective communication will be developed (Heinig, 1988). Knowing each other better and appreciating themselves as human beings is the one of the most important goals of the drama activities (Heinig, 1988; Philbin & Myers, 1991). When students thrust each other, they can freely express themselves. The more students feel comfortable, the more they learn. From the mathematics education perspective, the achievement and confidence in mathematics are significantly correlated (Kloosterman, 1988; Kloosterman & Cougan, 1994).

Confronting students with situations in which they investigate the invariants of geometrical figures and relations among them under experientially geometrical context could lead them to learn geometry concepts meaningfully. That is, in Vygotsky's (1967) words, a child's spontaneous concepts meet the systematicity and logic of adults (cited from Fosnot, 1995). When drama based activities are performed in geometry classrooms, the development of three kinds of cognitive processes - visualization processes, construction processes, and reasoning in relationship -which fulfill specific epistemological functions (Duval, 1998) could be achieved. By this way geometry could be used effectively to characterize and solve problems in other topics of mathematics, daily life, and other disciplines such as science and arts.

Phases of Drama Based Lessons

Generally drama based lessons consist of three parts: introduction, development, and quieting (Heinig, 1988). In the introduction part, *warm-up activities* are used to lead everyone goes in a relaxed mood, ready to work together in a harmony, trust each other and also have fun. Students need to "shift the gears and recharge their imaginations" (Cottrell, 1987, p.87) at the beginning of the lesson so that they can be ready and confident for the rest of the lesson. Warm-up activities also give students some hidden clues about the rest of the lesson (Heinig, 1988).

In the development part, *make-believe play* environment is created in which students are pretending as if something is happening and/or as if to be someone. *Make-believe play* creates natural place for dramatics moments and requires abstraction and imagination. *Make believe play* brings a metaphor which is a link constructed between the topic of the lesson and the real life. A frame and roles associated with students' actual experience and knowledge from daily life examples, conditions and situations are presented to the student to foster meaningful understanding. *Make believe play* is "essentially a mental activity where meaning is created by the symbolic use of actions and objects" (Bolton, 1986). Throughout any type of drama activity, there are a number of symbol systems used which help to create metaphor. These are "iconic" (the use of symbols; pictures, photos, letters); "enactive" (people making sense of the world by participating in active form) and "symbolic" (knowing through use of language) (Combs, 2001). In this metaphoric environment, students are posed with *dramatic moment* in which they faced with the tension of time, an obstacle to overcome, mission to accomplish, or status to be challenged (Neelands, 1991). One of the key concerns of the

drama is creating dramatic moment. *Dramatic moment*, which can also be called conflict or tension, means the struggle between opposing forces (Andersen, 2000). This is a necessary element in dramatic structure, since it gets the attention of the participants and keeps interest until it is resolved. It also provides to create suspense that keeps the students in a state of anticipation over the outcome of the problem (Heinig, 1988). By means of the dramatic moment, students feel the necessity of the solving problem or understanding the situation. In other words, conflicts provide motivation and reasons for the learning.

Dramatic moments force students to remove the obstacle, or accomplish the mission in given time. In order to get rid of these tensions, students have to create some ideas, discuss their ideas with their friends. The pressure and genuineness of the conflict can help children create new knowledge and make different and necessary connections (Booth, 1985). This means that, dramatic moment creates force to the participants to construct new knowledge and find necessary relations.

One or more different *drama techniques* (Heathcote & Herbert, 1985; Neelands, 1991; Swartz, 2002) *in education* such as mantle expert, analogy, still image, etc are used to achieve the objectives of lessons. Drama techniques determine the form of the dramatic activity and the way of the students behave. For a particular lesson, they are chosen by considering the appropriateness to the needs and experience of the group, the content, available time and space so that they will be effective (Neelands, 1991).

Lastly, in *quieting phase*, the key points of the activity are summarized. Students review what they have learned either by answering or solving the questions posed by the teacher, or presenting what they have learned by an improvisation that requires the use of knowledge learned. This phase is important to see whether learning and progress are accomplished or not.

Examples of Drama Based Lesson

Drama based lessons on geometry were piloted and field-tested in the 7th grade geometry classes with 12–13 years old students (Duatepe-Paksu & Ubuz, 2004a, 2004b, 2009). Two examples of drama based lessons for geometry are as follow.

Ring and Circle

In this one class hour lesson, students were required to understand the shape formed by equidistant points from a certain point; to distinguish the interior and exterior region of a ring; to distinguish the ring and the circle. The evaluation of the lesson in terms of the phases and techniques of drama based lessons appears below (see Table 1). The materials needed for this lesson were flashlight, string, rope, and 2 m x 2m tarps, scissors for each group; music CD and CD player.

Table 1: Evaluation of the Lesson on Ring and Circle in Terms of the Phases and Techniques of Drama Based Lessons

Introduction	
Warm-up activity	Every student was walking and singing in a line as if going to a scout camp, and talking in the role of camping scouts. Students were standing provided that everyone saw each other (in the form of ring) talking about the camp.
Development	
Social Metaphor	Scout camp setting
Make Believe Play	The role of camping scouts
Dramatic moments	Tension of the camping condition: Overcoming the obstacles of finding the way of getting the equal heat from the fire.

Drama techniques	Tension of the rain: Finding the way of protecting fire and themselves from the rain while getting equal heat from the fire Mantle of expert, role playing, analogy, teacher in role, and still image
Quitting	Students were asked to state five objects in the shape of ring and circle, to form ring and circle, and to identify the positions of several objects that are put either interior or exterior region of the ring or the circle.

At the introduction part of the lesson, the classroom was organized to provide more space and then students were told that they were scouts going to the camping site in a forest. Follow up they started to walk and sing in a line as if going to a scout camp with the company of music. After a minute walking and singing, they were told that they have arrived to the campsite and were asked to stand provided that everyone would be able to see each other. First they stand in two opposite lines. Then the teacher asked them whether everyone could see each other in that position. After a while, they realized that they should stand in the ring form in order to see each other. Later they were encouraged to discuss what they saw while walking to the camp side to get them ready for the rest of the lesson in a relaxed mode and communicate and express their feelings among other students as well as think and feel the camping environment. The things they saw were trees and animals such as rabbits, birds, squirrel, etc.

In the development part, students were grouped into scout teams consisted of 7-8 scouts. Each group were provided a flashlight and told that it was their camp fire around which they gathered. Then they were introduced two dramatic moments; finding that how they should be positioned to get heat equally and finding the way of protecting the fire and themselves from the rain while everyone gets heat equally from the fire. To overcome these given dramatic moments students behaved as a scout in a camp.

With searching for the ways to get the heat equally, students wanted to be close to the fire as much as possible. As the teacher was in the role of a scout leader, teacher asked them that why and how they get equal heat when they positioned like that. With these actions and answering such questions, they reached to the consensus that they should be positioned in the shape of a ring to get the heat equally. When asked them the reason for positioning in a ring form, they explained that they become at the equidistant from the fire and ultimately each one could get the heat equally. This leads the students to constitute the definition of ring.

With searching for the ways to protect the fire and themselves from the rain while they were positioned in the ring form, some students suggested that umbrella could be used to cover the heat and themselves. The use of umbrella, however, could create some problems: for example, every scout needs an umbrella and one umbrella is needed for the fire. That is, a lot of umbrella is needed and a scout is needed to hold the umbrella on the fire. In order to hold umbrella on the fire, you need to be close to the fire and this would create a danger. This kind of discussion was helpful to see the difficulty of covering the heat with umbrella. Then students posed that a roof could be constructed as they need something greater than the umbrella. But it was talked the impossibility of this at the forest and then some students suggested stretching water-proof cover. Upon this, the teacher showed the 2 m x 2m tarps and asked in which condition it can cover both the fire and the scouts around it.

Quitting part was devoted to a class discussion in which the students were asked to state the objects in the form of ring and circle, and to form ring and circle by coming together. Some examples of the objects stated for ring were metal ring, bracelet, scotch tape, etc and for circle were ball and plate.

Related to the objects stated by the students the teacher asked further questions as such “Can a ball be counted as a circle?”, “Can a plate be counted as a circle?”, and “What properties should be satisfied in order to be a circle?”. Based on these questions, some students stated that ball is not a circle since circle must be flat and you cannot roll it. From here, they understood that circle is two dimensional but ball is three dimensional.

While forming ring by coming together, the teacher asked the students to form three, four, and five rings to help them to form rings in different dimensions. Here students did not have any problem in forming rings as they had a lot of experience in previous part of the lesson. When they were asked to form circle, they first faltered and then they become circle something like in the development part. Then the teachers wanted them to form circle themselves without using tarp. Following up some students got inside the ring but then they realized that whole inside of it is not covered. Based on the teacher question “how we could achieve it”, they started to form rings one side the other.

As seen above, mantle of expert, role play, analogy, teacher in role, and still image were the drama techniques used in this lesson. For the mantle of expert, students were given the role of scouts who have knowledge and skills about the camp situation. The technique of role play was used along with the mantle of expert since students pretended as a scout by putting themselves in the role of scouts and imagining what scouts say, think and feel. They were grouped into scout teams of 7-8 scouts and introduced two dramatic moments arousing from the scout camp situation. Dramatic moments were revealed through working on a similar situation that reflects the real problem. Therefore an analogy was constructed between the camp situation and properties of ring and circle. Teacher in role was another technique used in this lesson. During the lesson, the teacher was in the role of a scout leader. This facilitated the students to discover importance of being equ-distant from a point, and find a way to protect the fire and themselves from the rain while getting equal heat. By this way the teacher controlled and guided activities, challenged and extended thoughts by taking roles as students. In order to make clear and emphasize the shape of ring and circle, the technique of still-image was used. The students were asked to form ring and circle by using their bodies or the part of their bodies like fingers, arms, etc..

Altitude of Triangle

In this one class hour lesson, students were required to discover that the shortest distance between the vertex and the opposite side of triangle was altitude. At the beginning of the lesson, the classroom was organized to create an empty space at the centre. The materials used for this lesson were music cassette or CD, cassette or CD player, ruler, protractor, enough piece of rope, and envelop involving (a) a letter asking students help, (b) a sketch of a spider web (40 cm x 40 cm) and (c) a triangle shape. The evaluation of the lesson in terms of the phases and techniques of drama based lessons appears below (see Table 2).

Table 2: Evaluation of the Lesson on Altitude of Triangle in Terms of the Phases and Techniques of Drama Based Lessons

Introduction	
Warm-up activity	Becoming a tree starting from a seed in the soil
Development	
Social Metaphor	Responding to a letter
Make Believe Play	In charge of the mission given by the Spiderman
Dramatic moments	Overcoming the obstacle Spiderman has faced: Finding the

	shortest road between Spiderman place and the road that his lover passes
Drama techniques	Letters, still image, writing (drawing) in role, analogy
Quieting	
	Forming triangles and their altitudes by using ropes and part of bodies.

In the warm up activity students were told that each of them was a little seed. Being a seed, they were told to imagine the progressive development of that seed under the ground up to getting a big tree. They were told that they could feel the breezing wind, squirrels and birds perching on the leaves by closing their eyes. Although some of the students were reluctant on closing their eyes at first, they followed the instruction after seeing their friends closing their eyes. Later, three of the students were invited to the center of the classroom. They were still in the form of trees and all students were asked the possible positions of these trees with respect to each other. Students responded that they can be in a line or any two of them can be in line. The aim of this part made the students to get ready for the rest of the lesson in a relaxed mode and to communicate and express their feelings among other students as well as think about triangle. Later students were questioned about the sides and vertex of the triangle posing questions as such "which parts are the vertices/sides?" to emphasize that a triangle is a polygon with three corners or vertices and three sides or edges which are line segments. This also formed a ground for an altitude of a triangle since it is a *straight line* through a vertex and perpendicular to the opposite side or an extension of the opposite side.

In the development part, the teacher announced that the class received a letter from one of the students' hero; Spiderman. The pre-prepared envelop enclosed (a) a letter asking students help about Spiderman's problem, (b) sketch of a spider web (40 cm x 40 cm) and (c) an enlarged part of the spider web (triangle shaped). Figure 1 displays the envelop contents.

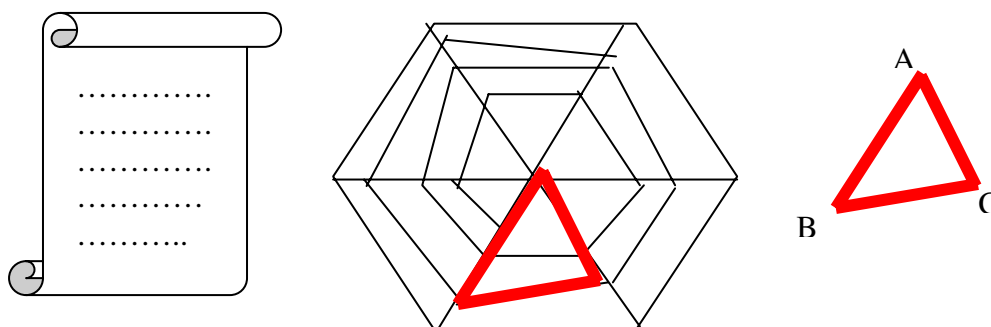


Figure 1. The Contents of the Envelop Received from Spiderman.

Envelop was opened and the shapes in it were hang on the wall of the class while the letter was being read by one of the students. In the letter, once saluting the students, Spiderman stated that his home was at vertex A and his lover Mary-Jane passes the road of BC. He wanted to go to the road that Mary-Jane passes from his house on a shortest way. Briefly, he asked students to find and draw shortest way between the point and the line.

Then students were grouped into four to help Spiderman to solve his problem. Each group was provided a copy of the triangle Spiderman sent as well as ruler and protractor; and encouraged to solve the problem. Groups with four members permitted to generate ideas for the discussion and solution of Spiderman's problem. The first inclination of the students was to draw a line that seems shorter. Then the teacher asked to the students that how you are being sure that it is the shortest way.

Following some student proposed that lines can be drawn from the point A to the points on the line BC, and then by measuring the length of these lines the shortest way can be found. By measuring the lengths and angles using ruler and protractor respectively students became aware of that the shortest way is a straight line through a vertex and perpendicular to the opposite side. If students had not drawn a perpendicular line from the point A to the BC, then the teacher drew that line asking whether it is shorter or not. Following up students realized that the shortest way was the altitude and drew it on the copy of the triangle. From the previous years students knew that an altitude of a triangle is a straight line through a vertex and perpendicular to the opposite side or an extension of the opposite side. Lastly, the groups were asked to draw the altitudes for other sides by using ruler and protractor.

At the end of the lesson, the students were asked to form triangles and their altitudes by using ropes and parts of their bodies. Students formed triangle using rope by standing at the corner of it. One student at one corner hold another rope and then the rope was stretched and tied to the appropriate place at the opposite side. Here students verified their finding about altitude empirically with physical involvement.

As seen above, letters, still image and writing (drawing) in role were the drama techniques used in this lesson. Students were given the mission by the letter received from Spiderman. For this mission students were in the charge of drawing the shortest way (altitude) from vertex to next side which is called the technique of drawing in role. The analogy of the shortest way from two points constructed here. The concept of shortest way in the Spiderman's problem indeed appears as an altitude of a triangle. With the intention of emphasizing the altitude, the technique of still-image was used and students were asked to form a triangle and its all three altitudes by using their bodies.

Perceptions of Teacher and Students

In this section teachers' and students' perceptions of the drama-based instruction are reported under two sub-headings: strengths and limitations of the drama based instruction. Strengths part is presented under active involvement, communication, and self-confidence. Further information about its strengths can be found elsewhere (Duatepe-Paksu & Ubuz, 2004a, 2004b, 2009).

Strength of the Drama Based Instruction

Active Involvement. Active involvement both physically and cognitively let students to engage in activities enthusiastically. This exciting and interesting classroom environment took their attention and provided them learn better.

Students' minds were busy with lesson. (Teacher)

We connected each lesson. We liked it. We participated and had to think about the lesson. We had to use our mind. (Student A)

This finding agrees with that of Reys, Suydam, Lindquist, and Smith (1998), who reported that children can learn best when mathematical topics are presented in an enjoyable and interesting way that challenges their intellectual development.

The topics were presented in an interesting way. The lesson became exciting for the students, and motivated them. So their attention was on the subject steadily. Since the lesson was more interesting to them, they understood more. (Teacher)

Geometry was more fun and easier. With the examples from life, it was more enjoyable. (Student B)

Absolutely, it was more fun. For example, constructing geometric shapes by our hands, arms and ropes was joyful. They were like stories; they were like the games we played in our childhood. (Student C)

By involving actively in activities students became the constructor of the personal knowledge rather than receivers and repeaters of the given knowledge. By this way learning became more meaningful, applicable and memorable (Davis, Maher, & Noddings, 1990).

Communication. Drama based activities brought the necessities of communication. Engaging in discussion and negotiation within or between groups in all phases of the lesson brings an intrinsic need for explanations and therefore appreciate the strength of justification as an explanatory tool. Talking about mathematics made it more alive and more personal thus lightened students' interest (Wragg & Brown, 1995). Students become consciously aware of what they were studying on. Moreover, drama based instruction made students and teachers operate at the same language level. This platform provided students understand geometry meaningfully and develop their geometric thinking level. This finding supports the views of van Hiele (1986), who reported that communicating at the same language provided students understand geometry meaningfully and develop their geometric thinking level.

They (students) had the opportunities to express their ideas. They criticized their friends' ideas. when you gave students opportunity to talk, even the most unrelated student paid attention to the lesson. Students think that, our friends were speaking, they were telling something. Therefore, they tried to understand what was going on in the classroom (Teacher).

... Now we are talking since the teacher keeps asking questions. We are discussing in order to answer the questions and solve the problems... Everyone could freely express his or her ideas. Everyone explained his/her opinion, and discussed something even in breaks. (Student D)

While everyone worked alone in the past, we were now discussing together. We concentrated on some issues and talked about them. We could explain our opinions freely. (Student E)

Self Confidence. In drama based instruction environment students realized their potential to succeed in mathematics, to create something, and to teach their friends. That is to say that student realized their individual talents which they were not aware before and therefore developed self-confidence in themselves. This was in line with the claim of Yassa (1999) who indicated that drama activities enabled students to search for new possibilities within themselves.

I think that, it (drama based instruction) improved the students' imagination and creativity... They became to feel confidence in themselves. (Teacher)

I learned that I could rely on myself when I learn something new. (Student F)

I created something by myself. I realized that I could produce something new. (Student G)

I thought that I could not solve mathematics problems and I can never succeed in mathematics. But in drama I have done something. I can tell my opinions without fear of teacher. Now, I believe that I have the ability to succeed in mathematics. (Student H)

I found out that I can teach my friends. (Student I)

Reys, Suydam, Lindquist, and Smith (1998) claimed that students' knowledge and beliefs about themselves as mathematics learners affects their performance in mathematics and their behaviors as they do mathematics.

Limitations of the Drama Based Instruction

During the interview, the main concerns or problems expressed by the classroom teacher about the drama based instruction were as follows: solving limited number of questions, initial difficulties in forming effective physical environment, providing high quality instructional materials, and handling a major shift in the roles of teacher and student.

Regular classroom arrangement is not appropriate to do drama based activities. You made some arrangement on the desks prior to each lesson. But teachers cannot do that every lesson. We can make the students to do that. (Teacher)

They were very good activities and I am very positive about them. But they require much patience. Some materials should be prepared for every lesson... Teacher has to prepare them or buy them. They are both endeavoring, time consuming and costly. For example, a teacher with seven hour lesson a day, cannot prepare the lesson that much. In addition to that, the lesson should be planned. In order to plan them, you have to be creative. Each teacher cannot prepare his/her lesson like this. (Teacher)

... the most negative part is that the bigger duty for the teacher than today; arranging the classroom, preparing lessons plans that can attract the attention of the students, making or finding some materials. (Teacher)

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