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Discursive positionings and emotions in a small group's learning of geometric definitions

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This research examines the discursive positionings and emotions related to them of a group of three seventh class students. We videoed the group of students' discussions regarding the definition of terms associated with the circle topic and interviewed them regarding their emotions during the process of defining the geometric terms. We used the discursive analysis of Evans, Morgan and Tsatsaroni to analyze the participants' positionings and emotions. The research results indicate that the learning atmosphere in the group was positive due to type of leadership that prevailed, as well as to the collaborative working with a technological tool. This atmosphere resulted in the students having positive emotions about their learning.

Keywords: Discursive affect, positionings, emotions, geometry, small group.

INTRODUCTION

Students' emotions have become a growing research area in educational psychology (Knollmann & Wild, 2007). Ingleton (1999) describes emotions as a powerful factor which encourages or inhibits effective learning. Furthermore, the affective aspect of students' mathematical learning (including beliefs, attitudes, and emotions) has a mutual relationship with the cognitive aspect of this learning (Sriraman, 2003). This puts studying the affective aspect of students' learning on the agenda of mathematics education research. Here we study students' positionings and emotions when learning geometry. To do that, we use the discursive positionings and emotions framework (Evans, Morgan, & Tsatsaroni, 2006; Morgan, Evans, & Tsatsaroni, 2002). The use of this framework enables us to analyse two aspects of students' learning

that affect other aspects of this learning, namely the social and the emotions aspects. Moreover, using the framework, we can examine how emotions are related to positionings, an issue that has not been attended to widely. More specifically, the social aspect is studied through looking at students' positionings and their expressions in language, as the use of pronouns, which indicates whether the group member feels insider or outsider to the learning taking place. This feeling could also affect the member's emotions. For example, the insider probably feels content and satisfied by the learning taking place.

The discursive positionings and emotions framework draws on social semiotics, pedagogic discourse theory and psychoanalysis, and studies emotion as discursive positioning. The analysis of learners' mathematical positioning and emotions, according to this framework, takes into consideration positionings available to the mathematics learners through their learning practices, where those positionings enable and constrain the learners' emotions, and where emotions are considered as shaped by power relations. Few studies used this framework that takes care of two primary aspects of students' mathematical learning (the social and the emotional) to analyze students' positioning and emotions in geometric situations. We will attempt to do that, specifically, when a group of seventh grade students works with Geogebra to discuss geometric terms associated with the circle's topic. The discursive analysis, its basis and its phases are described in more detail below.

A discourse is a system of signs that provides resources for participants to construct social meanings and identities, experience emotions, and account for actions. Evans (2006) names the following functions

of discourse: First, it defines how certain things are represented, thought about, and practiced; second, it provides resources for constructing meanings, and accounting for actions; and third, it helps construct identities and subjectivities that include affective characteristics and processes.

The discursive analysis of students' emotions and positioning has two phases: the structural and the textual. In the structural phase, learners' positionings are analyzed. Evans (2006) defines positioning as a process where a participant takes up and/or is put into one of the positionings made available by the discourse(s) at a specific context. This explains the mutual influence of the social and the individual, where the social setting makes available specific practices and thus positionings, and individuals retain a degree of agency that enables them to position themselves in available or created positionings. According to this framework, a person's identity, which includes more durable components of affect such as attitudes and beliefs, comes from repetitions of positionings, as well as their related emotional experiences that occur in the history of the participant (Evans, *ibid*). Evans, Morgan and Tsatsaroni, in their writings about discursive analysis describe the positionings taken care of in the structural analysis: Helper and seeker of help (helper positioned more powerfully), collaborator and solitary worker, director of activity and follower of directions (the latter less powerful), evaluator and evaluated, insider and outsider.

There is more than one available positioning for a participant, if in one discourse or in several discourses. Moreover, positioning is not permanent, not completely determined, nor freely chosen, where participants are constrained and enabled by their personal histories and the discursive resources available to them (*ibid*). Furthermore, in the 'progressive classroom', the positionings of the collaborator and insider are encouraged because they help advance students' learning of mathematics.

The second phase of discursive analysis (the textual analysis) has two functions (Evans, 2006): (a) showing how positionings in social interactions are actually taken up by the participants, and (b) providing indicators of emotional experience. Furthermore, in the textual analysis, indicators of interpersonal relationship and emotional experience are considered (Tsatsaroni, Evans, & Morgan, 2007). This analysis has

two stages. In the first stage, the focus is to identify the interpersonal aspects of the text that establish the positions of the participants. Indicators at this stage include reference to self and others, reference to valued statuses (e.g. claiming understanding or correctness), modality (indicating degrees of un/certainty), hidden agency (e.g., passive voice) or repetition. The second stage of the textual analysis attends to (a) indicators of emotional experience generally understood/used within the (sub) culture: direct verbal expression (e.g., 'I feel anxious'), use of particular metaphors (e.g. claiming to be 'coasting'), emphasis by words, gesture, intonation, or repetition (indicating strong feelings), body language (e.g., facial expression or blushing); (b) indicators suggested by psychoanalytic theory, as indicators of defenses against strong emotions like anxiety, or conflicts between positionings (as 'Freudian slips'), surprising error in problem solving, behaving strangely (as laughing nervously), denial (e.g., of anxiety).

Using the two phases of the discursive framework, we analyzed the positionings taken by seventh grade students and their related emotions when developing collaboratively, with the help of GeoGebra, the definition of geometric terms associated with the circle topic.

Research questions

- 1) How are positionings taken up by middle school students, working in a group to define geometric concepts in the presence of technology?
- 2) How are students' emotions associated with the positionings that they take up when they define geometric concepts with technology?
- 3) How does technology affect students' positionings and related emotions?

METHODOLOGY

Research setting and participants

We analysed in the present research the affective aspect of the learning of a group of three grade 7 students. Following is a description of this group, where the description is based on the evaluation of the students' mathematics teacher.

The group consisted of Haya (A high achieving student in mathematics with strong personality), Janan (A high achieving student in mathematics with a so-

ciable and friendly personality), and Rana (A middle achieving student in mathematics, who encountered learning difficulties due to family circumstances).

The three participating students did not work with GeoGebra before, and they were introduced to it in two hours' time. Furthermore, the students had learned the topic of the circle in the sixth grade, but they learned it then without GeoGebra.

Our analysis of one group's learning of geometric definitions attempts to shed light at students' positionings and related emotions, when they learn geometry with a technological tool. This analysis of just one group learning is consistent with previous studies that analysed different aspects of students learning (See for example Yerushalmy & Swidan, 2012). Nevertheless, we are aware that further research is needed to verify the results we arrive at.

Data collecting and analysing tools

We collected our data using observations of the group learning and interviews with its members. The group's learning was videoed and at the end of each lesson, the three students were interviewed individually regarding their positionings and emotions during learning. We analysed the two types of collected data using the discursive analysis framework presented above. Moreover, we combined the analyses of the data collected by the two tools.

Learning material

The group of seventh grade students worked with different activities, where they discussed the definitions of geometric concepts associated with the circle's topic. It was expected that performing the activities, the participants would deepen their knowledge regarding the concept of circle and its related concepts: circle's center, chord, radius, diameter, circle tangent, circle circumference and area. The activities were written keeping the explorative and discursive learning in mind. Below is an example on a question in the unit.

- (a) We want to draw a circle using Geogebra.
- (b) We want to draw a diameter in the circle.
- (c) Manipulating the diameter, how can we define it?
- (d) How many diameters are there in a circle?

- (e) What is the relation of the diameter and the chord?

FINDINGS AND ANALYSIS

We describe here the different learning events of the geometric concepts associated with the circle topic, together with students' positionings and related emotions that prevailed in these learning events. We start from the learning events as we consider students' positionings and emotions associated with these events.

Difficulty in defining the circle's center in spite of the group members being collaborators

The first requirement of the activity was to define the circle's center. Haya initiated the exploration of the group (1), by telling the group's members (she and two other members) that they should follow the directions of the activity (1 and 5), and by using GeoGebra to drag the circle. Then she addressed Janan and Rana (the other two members of the group), and started to discuss the circle's center, but soon the conversation turned to be about the chord (6-11), the diameter (6-11), the secant (12-17) and the tangent (12-17).

Note: When describing the learning events, silence for m moments will be denoted by [...m..].

- 1 Haya: The circle's center is
- 2 Janan: it is the point lying in the middle of the circle.
- 3 Haya: the middle ...
- 4 Janan: It is the center.
- 5 Haya (again): The circle's center is
- 6 Janan: every chord that passes through it becomes a diameter.
- 7 Haya: a diameter? [...15..] What is a diameter?
- 8 Janan: it is this that passes through the circle.
- 9 Haya: it is this that passes through the center and the circle.
- 10 Janan: it is a line that passes through any part of the circle.
- 11 Haya: if it passes through the center it becomes a diameter [Haya uses the mouse to drag the circle and watch how the diameter and radius change] ... the secant is like ... it intersects the circle in two points.

- 12 Rana: the tangent surrounds the entire circle [Rana and Janan were looking at GeoGebra interface].
- 13 Janan (vehemently): Yeh [Haya dragged the tangent again and again].
- 14 Rana: the tangent is this that touches the circle.
- 15 Janan (again vehemently): it does not intersect the circle. It touches the outer line. [Haya continues to drag the tangent].
- 16 Janan (looking at GeoGebra interface with interest): when the secant touches the circle it becomes a tangent.
- 17 Haya: the secant is like ... it intersects the circle in two points.

Haya played the role of the group director, though the whole conversation and actions seemed to be of collaborators more than of a director and two followers of directions. The collaboration occurred through asking questions and answering them, and through frequent attempts to agree on the definitions of the circle's center and other concepts associated with the circle. Haya seemed to be directing the activity, by two means: her persistence to ask questions and her use of GeoGebra to get new examples of the circle and its components. Haya's questions and actions led the group to improve their definitions of the concepts associated with the circle.

The facial expressions of the group members showed that they were enjoying their learning with GeoGebra as a group. This learning enabled them to improve, as a group (collaboratively) and on their own account (independently), their knowledge of the circle topic, which was represented in better statements about the diameter, the secant and the tangent [interview]. Furthermore, the improvement in the group knowledge empowered them, which made them content and happy [interview].

The group turned again to discuss the concept of the circle center, as the following learning event shows.

The group's director effort to come back to the original activity

Haya continued acting as the group leader. She declared they need to write the answer of the first question (18). She repeated the center's definition given earlier by Janan (19), and advanced the discussion further by asking another question to make that defini-

tion clearer (20). As a response to the question, Janan once again tried to describe the center (21). Haya tried to overcome the group difficulty in defining the center by investigating further the issue through dragging the center of the circle using GeoGebra (22). She announced again the mission of the group. So, Janan added another property to her definition of the center (23). Rana, contributed to the discussion by repeating Janan's first description of the center (24).

- 18 Haya: We have not answered the first question yet. What is the circle center?
- 19 Rana: a point. [..15..] [Haya wrote: a point lying in the middle of the circle].
- 20 Haya: how can we assign a point in the middle of the circle?
- 21 Janan: what? [..15..] before the radius.
- 22 [Haya dragged the circle center and the group described what happened to the circle and its components] Haya: We want to define the center of the circle.
- 23 Janan: it is the base of the circle.
- 24 Rana: It is a point lying in the middle.

Janan's behavior indicates her interim positioning as a follower of directions (21, 23). The silence indicates the group difficulty in defining the circle's center. In the interview, the group members said that their silence hid their frustration and uncomfortability due to feeling powerless because of their difficulty, as a group, in defining the center of the circle. Haya's work with the applet emphasizes her leadership. Her use of the pronoun 'we' (18, 20, 22), indicates she was an insider, and Janan's immediate answer (21, 23) indicates that she too was such. Rana's participation (24) also indicates her interim positioning as a collaborator. It seems that Rana, being not a strong student in mathematics, lessened her collaboration in the group discussion and mathematical work, which made her at the beginning less of an insider than the other two girls. This also made her feel neither content nor comfortable [interview]. Nevertheless, this did not prevent her from interfering and correcting the other members of the group when needed, as the following learning event shows.

Trying to be an insider and get involved in discussing the circle's radius

Once again Haya moved the mathematical talk away from its focus - the circle center (25), this time to answer the next question in the activity about the radius

of the circle. Probably she did that to change the negative mood of the group, becoming uncomfortable and frustrated because of their feeling powerless due to their difficulty to arrive at an accepted definition of the circle center. Janan tried, as before, to participate in the group's discussion (26, 29, 31), indicating she continued to look at herself as an insider.

- 25 Haya: How can we set the radius of the circle?
 26 Janan: we extend a line from the center.
 27 Rana: No, the radius.
 28 Haya: the radius. How can we set the radius?
 29 Janan: we extend a line from the center to the line of the circle.
 30 Haya (pointing at the circumference in GeoGebra interface): to the circumference.
 31 Janan: to the circumference, Yeh.
 32 Rana: according to the diameter length. [The facial expressions of the group members showed frustration]
 33 Haya: what is the radius of the circle?

Rana seems here trying to get power in the group, correcting Janan (27), and participating in the answering of the question about the setting of the radius (27, 32). Rana's contribution was not evaluated highly by the director of the group who again asked about the radius (33). This little acceptance of Rana's answer by the director of the group made her frustrated of her positioning in the group [interview]. Nevertheless, she tried to contribute again to the discussion, as can be seen from the following event.

Collaborating to define the diameter and discuss its relation with the chord:

The power of knowledge

Haya tried to define the radius (34). She stated her definition hesitantly, as if not confident of it. In spite of her hesitation, the two other members accepted her claim by repeating it (35–36). Haya then turned to read the next question in the activity (37). The three girls collaborated to define the diameter and describe its relation with the chord (38–43).

- 34 Haya (pointing at the circle in GeoGebra interface and saying in a hesitant voice): we write like this: "the radius is a line that starts at the center and extends to the circumference".

- 35 Janan: the radius is a line that goes from the center to the circumference.
 36 Rana repeats: From the center to the circumference.
 37 Haya read the next question: what is the diameter of the circle? [The group members looked at the diameter that they drew].
 38 Janan: It is a straight line that passes through the circle's center.
 39 Haya read the next question: what is the relation between the chord and the diameter? She answered: the diameter is in origin a chord passing through the circle's center.
 40 Janan: If it does not pass through the center it will be a chord, but if it passes through the center it will be a diameter.
 41 Haya: the diameter is a straight line that starts at the circle's circumference and passes through the circle's center.
 42 Rana: it ends at the second side of the circle.
 43 Haya wrote: the diameter is a straight line that starts at the circle's circumference, passes through the center and continues to the other side of the circle.

Again we see that the three students worked as collaborators, which led to their agreement on one of the definitions of the circle's diameter. Here, Haya maintained her firstness through reading the question and writing its answer. The two other students also contributed to the common knowledge of the group, which gave them more power. This power resulted in the two girls' satisfaction, as their facial expressions showed, which encouraged them to keep participating in the group discussions.

DISCUSSION AND CONCLUSIONS

In this paper, we analysed the positionings and related emotions of a group of students when defining geometric concepts associated with the circle's topic. Doing so, we used the discursive emotions framework suggested by Evans, Morgan and Tsatsaroni. This framework is a promising one since it is appropriate for complex context. This is so though it is difficult to incorporate some important constructs in it like previous students' experience and current learning beliefs.

The research results indicate that the director of the group's learning claimed her positioning by means of different behaviors: initiating the exploration work of the group, telling the group members what should be done to answer the activity questions, demonstrating persistence in asking questions that investigate the geometric topic, and in manipulating the geometric objects in GeoGebra. At the same time, the director of the group claimed her positioning by regulating the group members' emotions to avoid their negative emotions associated with their difficulties to define geometric concepts and to facilitate their engagement with their learning (Fried, 2011). As a result of this emotion regulation strategy of the group director, the interpersonal functioning of the group improved (Gross & John, 2003). It can be said that the actions of the group director, in the frame of her positioning as such, are related not only to the emotional aspect, but also to the different aspects of the group learning: the cognitive (asking questions related to the circle topic), the meta-cognitive (regulating the group's advancement through changing the discussed topic), the social (advancing the discussion of the group), the behavioral (manipulating GeoGebra), and the meta-affective (regulating the group's emotions) aspects. So, the group director claimed her positioning by means of administrative means more than by means of knowledge, though she asked and answered questions, and tried her most to contribute to the group process of defining the circle concepts. Thus discursive power could be claimed by administrative means, in addition to other means described in (Evans, Morgan, & Tsatsaroni, 2006), as knowledge and giving help.

To direct the group learning, the group director generally used the pronoun 'we' to initiate a journey with the group (Dafouz, 2007) regarding the learning of one of the concepts associated with the circle topic. This use of the plural personal pronoun indicates that the group director was an insider (Evans, Morgan, & Tsatsaroni, 2006) who took the lead in making the group succeeds in investigating the geometric topic.

Overall, the group members worked as collaborators. The collaboration of the group was facilitated by the group conversation, so it could be said that the leadership in this group was conversational leadership, where this conversation was seen by the group members, especially the director of the group, as a core process for effecting positive change (Hurley & Brown, 2010), in our case learning change.

Being collaborators, the group members worked with GeoGebra to further their study, were curious to move forward with their geometric investigations and were content and satisfied due to the power they acquired as a result of their collaborative knowledge advancement with the help of GeoGebra. Thus the technological tool facilitated their collaborative investigations of geometric concepts, empowering them as mathematics learners, and, as a result, causing them to have positive emotions about their learning of geometry. Moreover, in spite of these positive emotions, the group members had negative emotions when they had hard time defining the geometric concepts associated with the circle. These negative emotions were caused due to their feeling powerless not able to agree on the definition of the geometric concepts. The group members overcame their negative emotions by manipulating the geometric objects in GeoGebra and thus arriving at agreed definitions of the geometric concepts. Thus the technological tool empowered the group members, changing their negative emotions to positive ones. Furthermore, the technological tool not only empowered the group as a whole, but also empowered members who controlled the work with it, like Haya.

The group members' level in mathematics influenced the acceptance of the member to be an insider or outsider. Thus the two relatively strong members in mathematics accepted being insiders, while the middle achieving member did not accept at the beginning of the activity to be an insider regarding the learning happenings of the group, which made her frustrated from her positioning in the group. This situation changed as she tried to participate in the group's discussions and contributed to the knowledge development of the group about concepts related to the circle's topic. This change in her involvement with the group's work could be related to the group's perceived atmosphere, for the "members of a group will tend to behave according to the way they perceive the prevailing atmosphere" (Douglas, 1978; as in Gunn, 2007). This perceived atmosphere was characterized by being a positive learning atmosphere maintained by the group director. Moreover, this positive atmosphere gave power and freedom to the group members, enabling them to express themselves freely, and, as a result, causing them to have positive emotions: content, satisfaction and being happy.

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