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Student Voice in the Mobile Phone Environment:
A Grounded Theory Approach

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ABSTRACT

Student voice is recently attracting educational researchers' attention for its influence on various aspects of student lives and futures, as well as social life in general. Mobile technologies are proliferating in social and practical life. This article studies student voice in carrying out outdoor activities with mobile phones. Thirty middle school students participated in outdoor activities related to real life phenomena with the mobile phone. The research results indicate that the teacher's decisions and intentions to utilize the mobile technologies in the learning of mathematics outdoors set the stage for student voice in the mobile context. Furthermore, teacher support, the availability of the mobile phone and the outdoor activities facilitated student voice through enabling various students' actions and interactions: Freedom, autonomy, equality, participation, collaboration, decision making, sharing of ideas and taking the responsibility of the teacher. The consequences of students' learning in the outdoor mobile context included affective as well as social consequences.

KEYWORDS

Grounded Theory, Middle School, Mobile Phone, Student Voice

INTRODUCTION

Manefield, Collins, Moore, Mahar and Warne (2007) say that historically, the term 'student voice' ranges from a basic level to more sophisticated levels. At the basic level, the term refers to sharing opinions about solutions to problems through student councils or focus groups associated with school strategic planning. At a more sophisticated level, the term refers to sharing of 'voice' by collaborating with adults to improve educational outcomes, for example to improve teaching, curriculum and teacher-student relationships. Moreover, Education Alliance (2004) says that student voice implies a level of involvement, investment and engagement in school and learning. This is done through self-expression, feedback, opinion, choice, self-determination, representation, and empowerment (ibid). Some of the previous descriptions and categories are also expressed by Toshalis and Nakkula (2012), where student voice is considered a broad term that describes students' activities related to their expression, performance, and creativity. The term 'student voice' also refers to pedagogies in which students have the opportunity to influence decisions that shape their lives and those of their peers either in or outside of school settings (Mitra, 2009; Toshalis & Nakkula, 2012). Influencing decisions was mentioned by Schneider (1996), to give students voice in the classroom. Schneider (ibid) also suggested, as ways to give students voice, taking the responsibility of the teacher, reflecting on mistakes, giving students opportunities to make choices and reflecting on outcomes.

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Student voice is also connected to participatory teaching (Grion, 2014) and to democracy in the school and the classroom (Fielding, 2012), where this democracy is represented in different forms of partnerships and interactions between the teacher and the students. These forms of interactions could be: Students as data source, students as active respondents, students as co-enquirers, students as knowledge creators; students as joint authors, and shared commitment to/responsibility for the common good.

Talking about student voice in learning mathematics in the classroom, researchers referred to students sharing their solution strategies, students providing assistance to other students, students building on other students' thinking and students actively listening (Cao, Guo, Ding & Mok, 2013). Gallos Cronberg and Emanuelsson (2013) noted that the student's voice could be mediated by access to mathematical activities. The present research attempts to study student voice in outdoor mathematical activities, when carrying out activities assisted by a mobile phone.

MOBILE LEARNING

UNESCO (2013) argues that mobile devices are most appropriate for learning and teaching due to students' and teachers' use of the mobile technologies in different contexts for various teaching and learning purposes. Tatar, Roschelle, Vahey and Penuel (2003) say that mobile learning promises access to applications that support learning anywhere, anytime, and that this type of learning supports both adults at the workplace and students in classroom learning. Attewell (2005) describes the affordances of mobile learning: engaging learners, encouraging independent and collaborative learning, enabling learners to remain more focused, promoting self-confidence, helping overcome resistance using ICT in learning and helping to improve literacy and numeracy skills. Moreover, Wang, Shen, Novak and Pan (2009) found that university students, as a result of using a mobile learning system, changed from passive to engaged learners who are behaviourally, intellectually, and emotionally involved in their learning. Furthermore, Hwang and Chang (2015) found that location-aware mobile learning with a competition strategy significantly improved the students' learning identity, learning interest, and learning attitudes.

Regarding student voice in mobile learning, researchers suggest this learning to empower students (e.g., Liu, Navarrete, Maradiegue & Wivagg, 2014; Kim, Rueckert, Kim & Seo, 2013). Kim et al. (2013) point out that the use of mobile technologies in learning supports content through social communication, and thus this use empowers students' participation in collaborative learning environments. This support will be ensured if teachers design effective mobile learning environments that engage students in personalized learning experiences with mobile technologies (ibid). Researchers also suggest mobile learning for helping special needs students, as well as helping improve learning products (e.g., Devecchi, Mintz, & March, 2009). Devecchi, Mintz and March (2009) argue that consulting children at the earlier stages of software development contributes not only to the children themselves but to software development too.

As for studying students' voice in a technological environment in general, some attempts are being made recently (e.g., Grion & Manca, 2015). Moreover, DeWitt (2015) says that using technology, in the context of student voice, means the collaborative work of students and teachers, where students design their own learning, amplifying their voices in innovative ways.

RESEARCH RATIONALE AND GOALS

Toshalis and Nakkula (2012) argue that students will become more motivated and engaged in an activity when they have a voice in how it is conducted and can affect how it advances. Thus, they conclude, providing opportunities for choice, control, and collaboration is an effective strategy for increasing academic achievement. Our experiments with using the mobile phone to assist students' learning of mathematics through outdoor activities were intended to empower them through choice, control and collaboration. It was the goal of this research to study student voice in the context of using mobile phones in outdoor settings. To do so, grounded theory was used, which enabled us to look at different components of the student voice issue.

In addition to the above, integrating mobile technologies in student learning has been demonstrated to have positive impacts (Manga & Lu, 2013), but few attempts have been made to study student voice in the mobile technology environment (see for example Liu et al., 2014; Kim et al., 2013 for such attempts). The present research continues these attempts, utilizing the grounded theory approach and looking specifically at mathematical learning in the mobile phone environment.

Research questions:

1. What are the conditions for student voice when studying mathematics outdoors in the mobile phone environment?
2. What are the student voice's actions/interactions enabled when studying mathematics outdoors in the mobile phone environment?
3. What are the consequences of enabling student voice when studying mathematics outdoors in the mobile phone environment?

METHODOLOGY

Research Setting and Participants

The experiment took place in a middle school. It was led by three third year pre-service teachers majoring in mathematics and computers in an academic college of education. The three pre-service teachers carried out the experiment reported in this research as their final project in a mathematics didactics course whose instructor was the author. The project included a report in which the pre-service teachers examined how outdoor activities and the cellular phone affected the students' understanding of the function concept.

Thirty 8th grade students (whose ages ranged from 13.2 to 14.1 years, with a mean of 13.6 years) volunteered to participate in the project. The participating students' abilities varied, ranging from low-achieving to high achieving. All the learning was done by undertaking out-of-class activities that involved exploring the mathematics of real life phenomena. The students utilized the various characteristics and features of the cellular phone to do such exploration. At the beginning, the students carried out activities suggested by the pre-service teachers. Later in the experiment, when the students had carried out eight real world activities, they started to develop activities themselves. They did that by suggesting real world activities that they judged to be executable with cellular phones. The students usually started from a specific suggestion and developed it further till they considered the activity to be worth carrying out. Overall, the project lasted for twelve weeks including the carrying out of the activities suggested by the students. Moreover, the three pre-service teachers together led the thirty participating students in carrying out the outdoor activities.

Devices

The devices used were mostly of the brands Samsung Galaxy 2 and 3 and Apple iPhone 4 and 5.

The Mathematical Software

The middle school students worked with mobile phone software programs (midlets) from the Math4Mobile site (Yerushalmy & Weizman, 2007). The middle school students downloaded the midlets with the help of each other and the pre-service teachers. The midlets support the learning of algebra and geometry. In order to perform the activities, the students used the algebraic midlets and various tools and technologies embedded in their cellular phones. Mostly, the participants used the midlet "Fit2Go" which enables the user to draw specified points and then to fit a linear or a quadratic function for them. This midlet helped the students explore mathematically the real life phenomena for it enabled them to fit functions for those phenomena. This made them succeed to model mathematically those real life phenomena.

Outdoor Real Life Activities

The outdoor activities were carried out outside the classroom (in the school yard, in the students' houses, in the forest, etc.). They were related to real life phenomena (lived phenomena, like trees in the suburb, rocks in the mountain, the height and weight of a person, etc.). Two examples of the activities suggested by the pre-service teachers are (the first one is described in some detail): (1) Finding the relation between the weight and the height of the members of the group members: The students weighed each other and measured each other's height. Then they assigned points in the Fit2Go midlet, where each point fitted the measurements taken for one student; weight for x and height for y. (2) Finding the relation between the circumference of the trunk of a tree and the circumference of the biggest of its branches.

Students' learning with the mobile phone occurred in two phases. In the first phase, the students worked outdoors collecting information about the real life phenomena and trying to model these phenomena using mathematical models. In the second phase, the students discussed in the classroom the mathematical models they built and compared the models of the various groups.

After the students had carried out the activities suggested by the pre-service teachers, they were requested to suggest by themselves authentic activities that they could carry out with a mobile phone. Two examples of the activities suggested by the students were: (1) Finding the relation between the temperature of the water in a container and the time required for a cube of ice to melt in that water. (2) Finding the relation between the circumference of a rock and its height.

Data Collecting Tools

Data collecting was done through two main tools: videoing and interviewing.

- Videoing: The learning of the middle school students using the mobile phone to carry out outdoor mathematical activities was videoed and then transcribed.
- Interviews: The middle school students who participated in the experiment were interviewed after carrying out each activity for about thirty minutes about their experiences of learning mathematics with the cellular phone. The interview questions were semi structured and targeted the students' experiences and learning.

Examples of questions in the interview included: what difficulties did you have in carrying out the activities? What helped you overcome the difficulties you confronted in carrying out the activities?

Data Analysis Tools

The grounded theory approach (Strauss, & Corbin, 1998) was followed to identify the components of student voice in the outdoor mobile mathematical learning. This choice of grounded theory was due to the present research goal to study the student voice phenomenon in the mobile phone environment. This choice follows other researchers who studied educational phenomena related to mobile technologies, for example Pegrum, Oakley and Faulkner (2013). The grounded theory approach has three stages, as follows

1. Open coding: identification of repeated behavior. At this stage, we divided each type of collected data into segments and examined the segments for similarities and differences. The objective of this stage was to identify themes and categories of the participants' behavior related to student voice, place similar behaviors in the same category and characterize each category. In the present research, we arrived at this stage with the categories of teacher's support, students' autonomy and students' empowerment.
2. Axial coding: After identifying the categories and characterizing them, we examined the relations between the categories and their subcategories. In the present research, we characterized each category of student voice according to its characteristics. For example, we attempted to characterize the causal conditions for student voice, as for example the pre-service teachers' taking decisions to experiment with teaching with the mobile phone. Another component of the causal conditions is the influence of the mobile phone features on enabling student voice.
3. Selective coding: After refining the categories, subcategories and their characteristics, we identified core categories that could be used to connect the rest of the categories and to build a conceptual framework for student voice in mobile learning of mathematics outdoors. Within the conceptual framework, the categories and subcategories are described from several points of view: (1) the phenomenon that a set of actions/interactions attempts to manage or handle, in our case student voice; (2) causal conditions that lead to the occurrence of other categories or properties; (3) contextual conditions, namely the specific set of properties related to the phenomenon setting; (4) intervening conditions that act as either facilitators or constrainers of the actions/interactions pursued within the phenomenon; (5) actions/interactions aim for managing and handling a phenomenon within a context, given a set of conditions; and (6) consequences of the phenomenon resulting from the actions/interactions within the phenomenon.

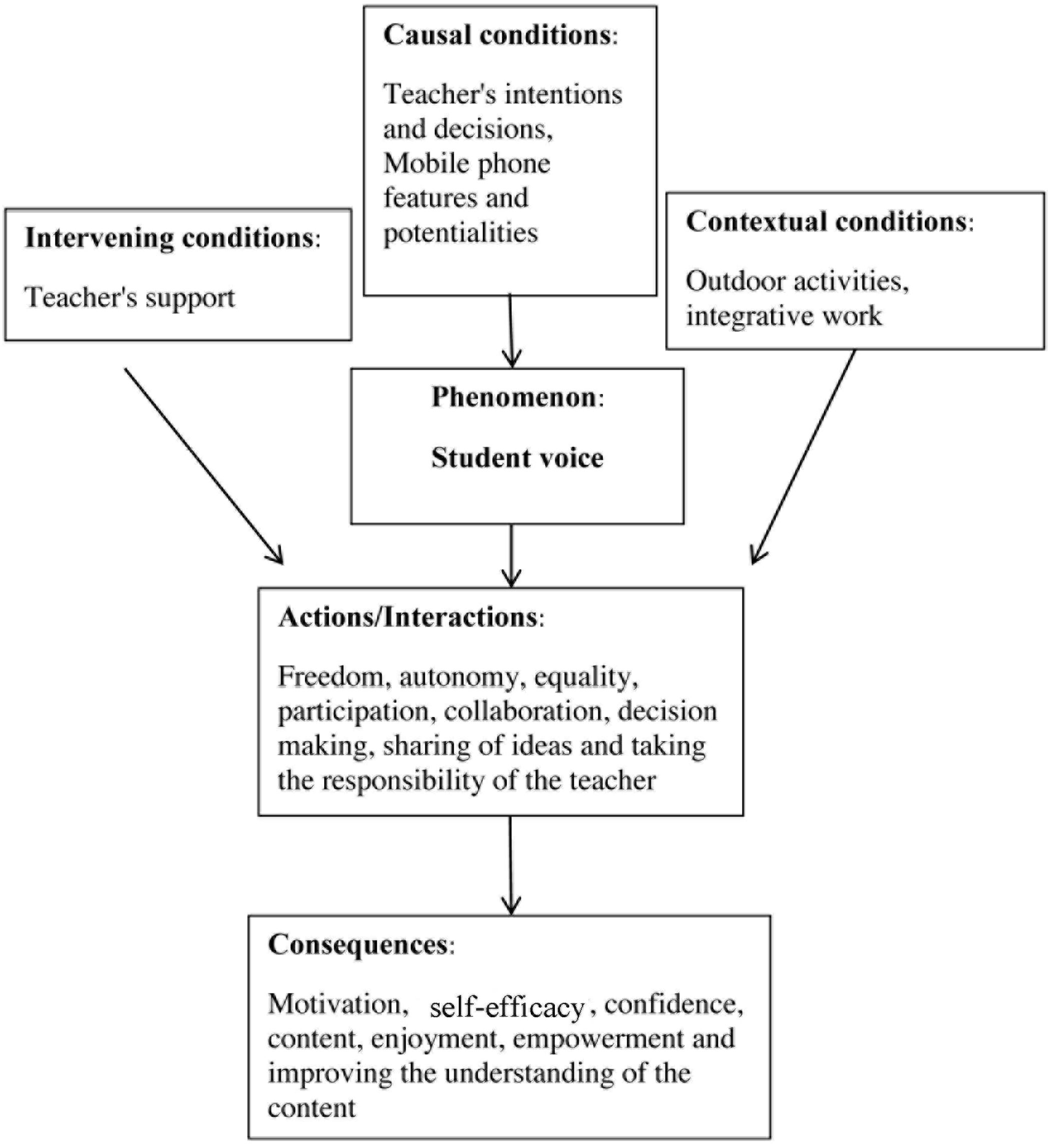
The results of the selective coding made connections among the various components of student voice. This coding, for example, made it clear that motivating students to learn mathematics was a result of encouraging their voice while carrying out the mathematical outdoor activities.

Validity and Reliability of the Analysis Method

The validity of the research analyzing procedure was guaranteed by the analysis method which ensured the theoretical saturation. This theoretical saturation is due to the existence of themes and categories, which ensures that no new category type will appear. Describing the categories also ensures that every category is well developed in terms of its properties and dimensions demonstrating variation (Strauss & Corbin, 1998, p. 212).

Lincoln and Guba (1985) say that no validity exists without reliability, so ensuring validity also ensures reliability. This means that theoretical saturation maintains not only the validity of the research procedure but also its reliability. Further, two experienced coders (one of them the author) coded the resulting themes and categories, searching for conditions, actions and interactions, and consequences of student voice. The agreement between the coders (Cohen's Kappa coefficient) (when satisfied) ensures the reliability of the qualitative coding. The computation of Cohen's Kappa coefficient resulted in .85 to .91 for the various categories related to the student voice phenomenon. These values are accepted for the agreement between coders.

Figure 1. Components of student voice in the mobile phone environment



FINDINGS

Figure 1 describes the various components of students' mathematical activity in the mobile phone environment, related to student voice, in the frame of the grounded theory.

Below is a description of each of the components, starting from the conditions of student voice, continuing to the actions interactions related to student voice enabled by the mobile phone environment and then describing the consequences of enabling student voice in the mobile phone environment.

CONDITIONS OF STUDENT VOICE IN THE MOBILE PHONE ENVIRONMENT

Here three types of conditions are described: causal conditions, contextual conditions and intervening conditions.

Causal Conditions

The main reason for students' experiences in mobile learning (carrying out outdoor mathematical activities, and having their own voice in that learning) is first of all the pre-service teachers' decision to give them this opportunity and examine how they manage to use technological tools in an outdoor context to study the function concept. Their intention was to let the students work in groups on their own to carry out the activities. This decision and intention encouraged student voice in the mobile setting.

A second main reason for the students' experiences in mobile learning and having their own voice in that learning is the mobile phone features and potentialities. The multiple functions and features of the mobile phone supported the students' participation and autonomy when carrying out the outdoor activities. Doing some of the activity actions with the mobile phone (taking pictures, recording video, assigning points and fitting a graph), they worked on their own carrying out outdoor activities, where the outdoor activities fitted working with the mobile phone and encouraged various autonomous learning actions of the students.

Contextual Conditions

Carrying out the outdoor activities needed the collaborative work of the students to perform material and mental processes in order to model the real life phenomena and arrive at the mathematical function representing the specific phenomenon. In other words, the outdoor activity encouraged the students' work to be integrative – their learning actions being dependent on each other. Being integrative, students' work encouraged their participation.

Intervening Conditions

The pre-service teachers' support for the students was crucial in strengthening the student voice in carrying out the outdoor activities. Their initial support provided the students with activities that can be carried out outdoors with the mobile phone on an autonomous and collaborative basis. In addition, the pre-service teachers gave the students the freedom to take whatever decisions they needed to take in order to plan and proceed with carrying out the activities. This attitude strengthened student voice in investigating the mathematical phenomena in the activities.

ACTIONS/INTERACTIONS RELATED TO STUDENT VOICE IN THE MOBILE PHONE ENVIRONMENT

Due to the centrality of students' actions/interactions to the studied phenomenon (student voice), every action/interaction will be described individually.

Freedom

The pre-service teachers described the project – carrying out outdoor mathematical activities, to grade eight students, giving them the freedom to participate in the project on a voluntary basis. The participating students thus participated in the mobile activities of their own free will. What made them persist in carrying out the outdoor activities in spite of the difficulties they confronted?

Abeer said, in her reply to the question on difficulties in carrying out the activities and how she overcame these difficulties: "Sometimes, it was hard to carry out the activities, as in the case of the rock activity. I kept reminding myself that I chose to participate in the activities of my own free will, so I should continue no matter what difficulties we have."

Autonomy

Autonomy made the students feel they were independent learners. This autonomy was realized in students' independent carrying out of the activities, where the pre-service teachers' main role was to lead the discussion when the students gathered to discuss their findings.

Hana expressed her contention that the students were autonomous, and what made them feel self-sufficient, saying: "We were autonomous and worked on our own during the greatest part of the activity. We felt self-efficient in learning mathematics through real life activities with the mobile phone."

Equality

The participating students expressed their belief that they were equal in the group and equal with the pre-service teacher. The equality in the group was realized through the ability of the students in a specific activity to choose the role that other students chose in previous activities. The equality with the pre-service teacher was realized through decision making, where the students had the power to decide regarding their learning, which was usually the role of the teacher.

Hana expressed her opinion that the group members had equal relations, saying: "We were all equal and exchanged the roles in the different activities."

Participation

Students' participation took many forms. These forms were related to the different aspects of their learning, especially the cognitive (fitting a graph for points resulting from the measurement), meta-cognitive (planning to solve the mathematical problem), behavioral (taking measurements), meta-behavioral (planning the measurements, for example which rock to measure), social (collaborating in carrying out the activities) and meta-social aspects (agreeing on the role of each other).

Hana expressed the need for the continuous planning of the activity: "We planned the activity at the beginning, but we needed sometimes, due to difficulties in performing the activity, to stop and make changes to our plan."

Salma valued the agreement process of each participant's role: "It was important to agree on each one's role from the beginning. This gave us the chance to choose and to decide, taking into consideration each other's desire."

Collaboration

Students' collaboration existed in each of the activity phases, outdoors and in the classroom. This collaboration was a result of the nature of the outdoor activities that necessitated carrying out different learning actions. These learning actions necessitated, in their turn, collaborative work to be efficiently carried out.

Salim expressed the need for collaboration: "Working outdoors makes our collaboration a necessity, for we constituted a group who need to carry out an activity and a plan for that activity. This made us value working in groups, unlike working in class where collaboration is not always needed."

Decision Making

The students had the opportunity to make decisions on different occasions while carrying out the activities. At the beginning, they decided how to form the groups. For example, they decided who will be in the group. Afterwards, they decided the roles of each member of the group: doing the measurements, taking pictures, writing the measurements on a paper, assigning the points resulting from the measurements in the Fit2Go midlet, and fitting a graph to the points. In the second phase, they decided which function best suited the real life phenomenon.

Abeer expressed her awareness of the role of decision making in performing the activities: "Performing the activities meant taking decisions all along the activity. We could say that learning needs to involve taking decisions in order to be successful."

Sharing of Ideas

The students shared ideas in each of the two phases of the activity. First they shared their ideas outdoors in the one group, regarding the type of function fitting the data collected about the real life phenomenon, whether it should be linear or quadratic. Second they shared their ideas in the second phase of the activity, discussing the mathematical models that they arrived at, their similarities and differences and what the best model would be.

Salma said in the interview: "Only by sharing our ideas we arrived, at the end, at the best function fitting the data that we gathered."

Taking the Responsibility of the Teacher

The students were fully responsible for their learning in the outdoor part of their activities, but the most representative behavior of their taking the responsibility of the teacher came when they wrote activities appropriate for carrying out outdoors with the mobile phone. Not only did they write the activities but carried them out too. This writing of the activities generally falls in the teacher's role, but the intention of the teacher, combined with the outdoor setting, made it possible for the students to author appropriate activities for their own learning.

The students expressed their enjoyment for writing activities for their own learning and carrying them out. Sana said: "I was glad for carrying out activities that we wrote. We felt what it means to be a teacher and to write activities that could be solved."

CONSEQUENCES OF ENABLING STUDENT VOICE IN THE MOBILE PHONE ENVIRONMENT

The participating students' actions/interactions in carrying out outdoor activities with the mobile phone had psychological and affective consequences, namely motivation, self-efficacy, being content and enjoyment. At the same time, they had social consequences, especially empowerment. Moreover, the participating students said that having the freedom and autonomy to carry out the activities, their sharing of ideas and their working collaboratively helped them explore the outdoor phenomena mathematically and build models that fitted it.

Sana said: "Writing activities for our own learning motivated us to carry out these activities with enjoyment. This proved that we can be responsible about our own learning. This made us feel powerful."

DISCUSSION AND CONCLUSIONS

Miangah and Nezarat (2012) describe mobile learning as more useful for doing activities outside the classroom, where mobile technologies and activities enable learning to be directly connected with real world experiments. We utilized mobile learning in middle school students' carrying out of outdoor activities, and examined the various components of this learning regarding student voice. The research results indicate that the teacher's decisions and intentions to utilize the mobile technologies in the learning of mathematics outdoors set the stage for the prevalence of student voice in the mobile context. Furthermore, other educational components influenced student voice in the mobile context: the teacher's support, the availability of the mobile phone and the outdoor activities. These conditions joined to facilitate the various factors of students' actions and interactions: autonomy, freedom, participation, etc. These results support previous research results regarding the roles that the three educational constructs (teacher's behavior, educational tools and learning activities), in our case the conditions for the prevalence of student voice, play in mobile learning (e.g., Baya'a & Daher, 2010). In addition, Cisco (2010) argues that the use of familiar technology can help students engage more directly with learning, and gain confidence in their own skills. In our case, this influence occurred in the form of students' actions/interactions and the consequences of the prevalence of student voice, as result of various conditions.

It could be argued, regarding the participating students' actions/interactions, that as a consequence of their mobile learning, they had the opportunity to influence decisions that shaped their learning activities outside of school settings (Mitra, 2009; Toshalis & Nakkula, 2012). These actions/interactions indicate that the conditions of students' learning enabled a democratic environment in which the students had different types of interactions among themselves and with the teacher (e.g., co-enquirers, knowledge creators; and shared responsibility for knowledge creation) (Fielding, 2012). This democratic environment is expressed not only in the different interactions but also by other democratic expressions as autonomy, freedom and equality. These democratic expressions further indicate the prevalence of student voice in the mobile environment (ibid). In addition, other actions/interactions in outdoor mobile settings indicate the prevalence of student voice in the mobile outdoor environment: making decisions and taking the responsibility of the teacher (Schneider, 1996) and sharing of ideas and solutions (Cao, Guo, Ding & Mok, 2013).

In addition to the above, enabling student voice in the mobile phone environment made it possible for the participating students to succeed in carrying out the mathematical outdoor activities even when they had difficulties in doing so. This was due to the learning characteristics of collaboration, sharing ideas and deciding to join the experiment of one's own free will.

It can be concluded that the prevalence of student voice in the mobile educational setting, as the present research indicates, was mediated by access to mathematical tasks (Gallos Cronberg & Emanuelsson, 2013) and mobile technology (Liu et al., 2014). This strengthens previous research results, such as those of Liu et al. (2014), who found that the utilization of mobile technologies empowers students, or those of Kim et al. (2013), who found that the use of mobile technologies empowers students' participation in collaborative learning environments. In our case, as Kim et al. (ibid) remark, this empowerment was ensured because of the effective mobile learning environments designed by the pre-service teachers.

In addition, the present research emphasizes the affordances of the mobile phones in positively impacting students' learning, here through encouraging their voice. Specifically, the mobile phone technology encourages students' motivation (Seifert, 2015), self-efficacy (Burton, Frazier, Annetta, Lamb, Cheng & Chmiel, 2011), confidence, content, enjoyment (Daher, 2010), empowerment and the understanding of the content (Daher & Baya'a, 2012).

LIMITATIONS OF THE RESEARCH AND IMPLICATIONS FOR PRACTICE

Using the mobile phone in teaching, as this research indicates, supports student voice and thus ensures effective learning. So, mathematics teachers in particular and teachers in general can utilize the mobile phone in their teaching in the classroom to ensure effective teaching and support student voice. This also will result in student motivation, self-efficiency, confidence, contentment, enjoyment and empowerment. This means that using the mobile phone in particular and mobile devices in general can assist in ensuring cognitive, affective and social learning.

The limitations of the present experiment are in its participants, where few participants participated in the research (30 students). Moreover, these participants were only eighth graders. Furthermore, the present research addresses only the learning of mathematics. Further research is needed to study student voice in the mobile phone environment where more students from different grades and disciplines are involved.

OPEN DATA, ETHICS AND CONFLICTS OF INTEREST

No open data or conflict of interest exists regarding the present research. This paper utilized data collected by pre-service teachers for their third year project. Their project studied students' learning of the function concept (a cognitive aspect of learning) and had nothing to do with student voice. The pre-service teachers wrote a consent that their data may be used by the author for studying different educational aspects.

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