ETHIOPIAN PREPARATORY STUDENTS' PERCEPTIONS OF THE RELEVANCE OF MATHEMATICS TO LEARNING GOALS

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***Abstract**: This study investigates Ethiopian students' perceptions of the relevance of mathematics to their learning goals. Interview, classroom observation and survey were used to examine students' perceptions in the cultural, economic, historical and social context they are situated. The results indicate that participants in this study hold perception of the relevance of mathematics which is characterized by unknown future, trust, identity, empowerment to make informal decision and exchange value, which are held to various levels of strengths, with the characterizations trust, unknown future, and exchange value being strongly held. They are motivational factors to students' engaging in mathematics, and emotion is intertwined with them.*

Key words: emotion, Ethiopia, identity, motivation, perception, relevance

INTRODUCTION

In Ethiopia the transformation of schooling from indigenous to modern one occurred on a contradictory situation: the religious and cultural background of the country on the one hand and the need for modernizing the country on the other (Wagaw, 1979). Historically, education in Ethiopia is viewed as a means for betterment of life of the individual and her/his family (ibid). The contradiction seems to have contributed to the society's perception of schooling as a means of getting job than a means to solve societal problems. The students find themselves in this historical context of schooling. Literature suggests that students' perceptions about the relevance of tasks to their goals are motivational factor to their engaging in it (Wigfield, Hoa & Klauda, 2008). On the other hand students' motivation to engage in mathematical tasks affects their performance, and their perceptions about accessibility of the goals affect their motivations (Hannula, 2006). Students' regulate their emotions in order to achieve their goals (ibid). According to Wigfield, et al (2008) the importance of a task is associated with the individual's identity. There are diverse ways to motivate students to engage in mathematics. The rationale for their learning of mathematics could be a motivational factor for engaging in mathematics (Wæge, 2007). This study is carried out in a school in the capital of Ethiopia. A preliminary result from a pilot study which exposed the characterizations of students' perceptions of the relevance of mathematics was reported in earlier paper (Gebremichael, Goodchild & Nygaard, 2011). A questionnaire was designed and a survey was undertaken based on these results. The purpose of this paper is to report on the characterizations of Ethiopian students' perceptions of the relevance of mathematics with respect to their learning goals; the strengths of these perceptions, and their distribution across the categories of students. The research questions that I try to answer in this paper are 'what are the characterizations of Ethiopian students' perceptions of the relevance of

mathematics with respect to their learning goals; how strongly are these perceptions held, and do these perceptions have the same distribution across different categories of students'. This paper is structured in such a way that the theoretical perspective is followed by the methodology. Next, the qualitative and quantitative data analyses are presented, followed by the conclusion.

THEORETICAL PERSPECTIVES

In this study the theoretical perspective adopted is sociocultural theory, particularly, cultural historical activity theory (CHAT), which is discussed in more detail in Gebremichael et al (2011). The Engeström model (Cole & Engeström, 1993) is used as an analytic tool to describe and analyze the students' perceptions of relevance. The model depicts the activity system, which involves the interaction between the subject (students) and the object (motives, goals, learning school subjects including mathematics and material resources) mediated by tools and artifacts. This interaction is also mediated by the rules, the division of labor, and the community. In their participation in the activity of schooling, students have motives. They belong to a community of natural science or social science streams. The members of the school community are governed by the school rules. The school rules enforce that they should take school subjects including mathematics. They should cover certain topics over the year based on a mandatory textbook, which is a mediating artifact for their learning as well as the resulting perception. In their out-of-school lives students participate in the activity of family life where members of the family as a community share a common motive of survival of the family and a goal of enhancing the personal development of the student. According to the division of labor in the local activity system, students have responsibilities of mentoring their younger brother or sister as they are mentored by their elders. For many students, their parents are unlikely to know what they are learning, as the parents may not have the appropriate education. Moreover, the preparatory school system is a new system which is only introduced in 2003 and replaced the freshman program of universities. The students in this study are situated in a historical context of schooling and learning mathematics. They have been learning mathematics before they were enrolled in preparatory school and their elders have been learning preparatory mathematics. In the model, perception is in the subject. Emotion, motivation and identity are integral to each other; where the latter are derivatives of the first and are distributed all over the activity system (Roth, 2007). It is in such a framework that the students' perception of relevance develops. Following Vygotsky (1978) perception is understood in this study as a formation of meaning and making sense of an encountered mathematical experience.

METHODOLOGICAL ISSUES

This study employs a mixed approach, in which interviews, classroom observation and questionnaire are used to collect data in a school where I taught more than a decade ago. The students of this school are both sex. They are divided into two grade

levels and two streams. The teacher further divided them into levels of achievement. These student categories were used for sampling both in the qualitative and quantitative data collection. They are of age 16 - 18, with a possibility of few exceptions. I undertook a pilot study using group interview, supported by classroom observation. A total of 24 students participated in the interviews which were selected by homeroom teachers (teachers who have a firsthand responsibility for a class of students). Four homeroom teachers who are also mathematics teachers were selected by the department head, and they selected six students from their respective classrooms. Three students of the same sex who are high, medium and low achievers were interviewed together. Analysis of the data was carried out using narrative analysis; as a result the characterizations of students' perceptions were identified. Using results of the analysis of the pilot data, questionnaire was developed. In particular, the characterizations emerged were used as Likert scale questionnaire items, and 335 students completed it. The data was analyzed using quantitative methods, which is discussed in the data analysis part.

QUALITATIVE DATA PRESENTATION AND ANALYSIS

The five themes pertaining to students learning goals and the mediational process that regulated the development of these perceptions are presented here.

Mathematics is relevant because it is useful in an unknown future

The students are preparing for university studies and they have set goals associated with it. Students' form perception of the relevance of mathematics related to this.

> Andualem: Is math useful for your future? How about the math you are learning now?
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> Habtu: I want to study astronomy and my brother told me that in addition to mathematics, physics is the base.
>
> Abebe: I don't know the detail about astronomy and how much mathematical capacity it requires. Since mathematic is important in our everyday activities, it would be the same at that level. I think it would be important.
>
> Meseret: [Mathematics] is a mother tongue. … In economics there is slope. We learnt it in 7th or 8th. We didn't know then that it has this use.
>
> Makida: In books we don't see where to apply [it]. [It] has relation with other subjects and we apply it on them… at tertiary level.

As Habtu is participating in the activity of family life, he is mentored by his elder brother towards enhancing his personal development. The local community mediates his perception. Meseret considers her prior experience and projects it to her future. They perceive that the mathematics they are learning at preparatory is relevant to their future goals. The other subjects, school rules and artifacts mediate their perceptions. The school curriculum and the textbook do not give a rationale for learning the topics with respect to their future, and their perceptions are motivational factor for engaging (cf. Wæge, 2007). It is discussed in "identity" that students set

goals based on their relationship with mathematics, and in "exchange value" that mathematics determines their access to what they intend to attain in the future.

Mathematics is relevant because I trust the curriculum

There is a sense of trust by the students in the curriculum and/or the teacher.

Andualem: Why are you learning mathematics? Is it useful?

Asad: It is mentioned in the objective of the textbook. … I do not exactly remember specific examples. … I think it is because we should learn it.

Meada: In the objective it says 'at the end of this lesson you will be able to understand'. … [Limit] is used in derivative.

Ruth: Our teacher usually tells us.

Azenegash: [The teacher] is our eye… If it were not relevant we wouldn't have been taught. I think it is useful.

Asad perceives that they learn mathematics because they should learn it. In his participation in the activity of schooling to realize his motive of joining the university, he undertakes actions such as engaging in mathematical tasks and attending mathematics lessons. These actions are directed towards the goal of learning mathematics. He forms certain perception about the relevance of mathematics, which in this case is characterized by trust for the curriculum. When he is engaged in mathematical tasks the textbook is an artifact he uses. The textbook mediates his perceptions about the relevance of mathematics. Following Asad, another member of the same group, Meada explains what the objective informs and he gives a specific example. My review of the chapter on limits in the textbook confirms Meada's statement. In one of the bullet points that lists the objectives it mentions that the concept of limit gives a basis for differential calculus. This provides a sense of rationale for their learning of the concept of limit if they know what differential calculus is for. The textbook tells what the student should expect to learn by the end of a chapter. This might prepare the students to what they should learn and what they should pay attention to. However, the textbook does not give a clearly articulated rationale for their learning of the concept of limit, particularly with respect to the students' future goal. The students have a high assumption of the teacher and their trust for the curriculum is mediated by the teacher. This is seen in Ruth's and Azenegash's narratives. The teacher and her/his practice mediate their perception which is characterized by trust. The rules, the division of labor in the school, where their role is to listen to the teacher mediate their perceptions.

Mathematics is relevant because it gives an identity

Students form their identity in relation to mathematics and their future goal.

Andualem: Is math useful for your future? How about the math you are learning now?

Debesh: I want to study Banking and Insurance because it has mathematics …. I like mathematics … it is not difficult for me.

Essayas: I want to study law because my brother told me that it doesn't involve mathematics … economics, but [it] has mathematics; so I don't like.

Andualem: Do you find problems or examples which indicate that math has application?

Ruth: … Most social science students do not like mathematics. Only few students work hard. Thus our teacher always advises us.

Debesh perceives himself as someone who can do mathematics well, and this sense of identity is a motivational factor towards making a decision about what he has to study in the future. Essayas, on the other hand, perceives himself as someone who does not want to deal with mathematics. They are identified by their teacher as high and low achievers, respectively. In order to realize their motive becoming university student, they attend classes and study school subjects towards achieving the goal of learning. There is emotion intertwined with their object and their decisions (cf. Roth, 2007). Their perceptions are mediated by the local community, and the emotion towards mathematics. For both Debesh and Essayas their emotions and identities are motivational factors in engaging in mathematics.

Ruth is a high achieving and in other discussions as well she refers to the whole of students, and the social science when locating herself in the mathematics classroom. She is situated in the community of social science students who generally do not like mathematics and are taught by a mathematics teacher whose background is natural science. In the division of labor the teacher has the role of providing advice about working hard while the students have to listen to it. The teacher could tell them to work hard on mathematics and that it is important for their educational career. But, the student could not know how the mathematics they are learning would help them. The contradiction that Ruth experiences within her community seems to lead to a development of perception that is characterized by trust. There is emotion involved in here as well because the advice was initiated because of the social emotion exhibited among students. Emotion, Identity and motivation are intertwined to each other. The former two influence one another and affect the later (cf. Roth, 2007).

Mathematics is relevant because it empowers one to make informal decisions

Some students make judgments about what mathematics is for. Some perceive that mathematics and the other subjects are there for them to expose their talents.

Andualem: Why do you need to learn the mathematics you are learning now?

Erikihun: I want to study language or philosophy. … I am doing well in language. … Math and most of the subjects we are learning now might not be related to what we learn in the future. But, they help us to identify/know our interest and direct us to the future. We used to learn music; it is not important but if

you have the interest then you will know. Some of us may end up in a field that doesn't involve math at all but others may need it.

In his history of participating in the historical activity of schooling he has been undertaking actions towards the goal of learning. In particular, he was attending to school subjects including mathematics, music, English, etc. before he was enrolled in preparatory school. He is still attending to some of these school subjects. He perceives that the other subjects are competing with mathematics for students' choice or attention. Since he made other choices, he perceives that he doesn't need mathematics for his future, but he has to learn it because others in his group need it. The school rule enforces the topics that the student should cover in a year, and it has the responsibility of enabling him to understand why he is learning the school subjects. His perception is mediated by the other subjects, the school rules and community. The perception of relevance which is characterized by informal decision is a development from the contradiction within the object: the learning of mathematics and Erikihun's goal are in contradiction. We also see that his perception of relevance is a motivational factor, and negative one. His emotion determines his future direction and emotion is intertwined with his perception (cf. Roth, 2007).

Andualem: Do the mathematics textbooks reflect that math is useful? Do you see examples that show applications?

Netsanet: Before we use formulas, there are items which we do simply by observation, by looking at it attentively. That helps you to think and analyze; it broadens your mental capacity.

Netsanet perceive that mathematics is there to broaden her mental capacity. Her perception is mediated by the school curriculum, artifacts, the formula, and the prior meaning established in her about formula and other mathematical artifacts. The perception emerged as a development from the tension between the object and the rules. Her perception of relevance about the mathematics she is learning observed to be exciting for her and seems to motivate her to work on mathematics.

Mathematics is relevant because it has exchange value

These students are supposed to score a qualifying grade to be admitted to the university, and Ethiopia is a poor country in which success in education and securing a job relates to sustaining the life of the individual as well as parents.

Andualem: Tell me your history in schooling and your experiences in mathematics?

Beza: We used to hear that 10th is the turning point for life. … [Studying] any social science would be ok [to be a hostess]. … Mathematics is compulsory.

She plans to become a hostess, and she perceives that the school that offers the training requires social science background of university. She is sure that success in mathematics is the gate keeper to joining the university and to achieving the goal of

securing a job – becoming a hostess. This perception of relevance she attaches to mathematics motivates her engaging in mathematics.

Andualem: What do you plan to study? Is mathematics useful for your plan of study?

Ruth: Earlier I wanted to study law but it is 5 years. [I] study economics … then I can help my parents. … If I do not have the basis in mathematics I can't do it.

Ahadu: I want to become a [medical] doctor. … Whether one becomes a medical doctor or something else, learning mathematics is part of the process.

Ruth learns mathematics to sell it at the marketplace of learning economics so as to get job at the end which enables her to sustain her family and study law which she really likes to study. The division of labor in her community – her responsibility to support her parents – mediates her perception of relevance. Her perception of relevance is a motivational factor for being engaged in mathematics. Ahadu perceives that one cannot make her/his way to the future without dealing with mathematics. His perception is mediated by the rules.

Andualem: What do you plan to study? Do you see application of mathematics?

Yirdaw: I want to be a private accountant. … Mathematics books from abroad are better at applications than domestic ones. … I prefer the [latter] for success in exams. But, for my interest I prefer the [former]".

Andualem: Do you find learning mathematics useful? Are the concepts you learnt this year of interest to you?

Alewi: I am not interested in it but it is required … I liked polynomial at the beginning. … when I scored poor at the first test, I turned my back to it again".

We see the contradictions between the mediating artifacts that are available for Yirdaw and the school rules that he has to succeed in examinations which are pertinent to the text book. The contradiction results in the development of his perception. Emotion that is associated with the artifacts is exhibited in his interest in using some of the artifacts than the others. Emotion also mediates students' perceptions. Though Alewi did not like it, because of the exchange value mathematics has, she put effort to succeed. Cognizant of the fact that her effort is in vain she dropped it as less relevant. Emotion is integral to and affects her perception of relevance. Her motivation is also seen to decline as a result.

PRESENTATION OF QUANTITATIVE DATA ANALYSIS

The results of the quantitative analysis about strengths of students' perceptions; differences between categories of students and parents educational backgrounds are presented here. A large proportion of the students' parents do not have education that enables them help the students in their education. More than 63% of the mothers do not have any training above secondary level, while only 15% of them have training above secondary level. Only less than 6% of the mothers have university degrees.

Their fathers' do not seem to be far different from their mothers'. More than 52% of the fathers do not have any training above secondary level, while 25% of them have training above secondary level. Only less than 16% of the fathers have university degrees. About 22% of the students mention neither their fathers' nor their mother's levels of education. On the other hand, the students hold the five characterizations of perception to various degrees of strengths. The proportion of students who held perceptions characterized by trust is 71%; unknown future, 68%; exchange value, 63%; identity, 43% and decision, 33%. The first three are strongly held. Though the perceptions characterized by identity and decision are not strongly held, a significant proportion of students hold these perceptions. Identity especially is significant, when compared to the proportion of students who do not hold this perception, which is 31%. The item on future use of mathematics is about something which the students did not experience yet. A follow up question was asked, about their sources of information. For 64 % of the students their teacher is their source of information. Their mothers, fathers, brothers, sisters, or relatives are very rare sources.

Four of the five characterizations of students' perceptions did not show any significant difference based on the categories of gender, grade level, stream and levels of achievements. The distribution of items such as "preparatory mathematics is useful to get access to my future plan" is the same across all categories. This was tested using bar graphs as well as the Mann - Whitney U Test (and Kruskal-Wallis Test in the case of three categories) (Field, 2009). One exception is perception about their future plan. That is, the students' responses for the item 'preparatory mathematics is useful in what I plan to learn in the future" had different distributions across the two streams. The results obtained from SPSS using the Mann-Whitney U test suggests that the null hypothesis that this characterization is the same across categories of stream should be rejected because its significance value, which is 0.014, is less than the significance level, 0.05. However, the distribution of this characterization is the same across the other categories. This is probably because of the nearly uniform school related situations that prevail. The mandatory use of a single textbook together with the teacher's guide at each grade level, might make students' prior experiences with respect to schooling and mathematics classroom more or less the same. As it has been explained earlier the natural science and social science students use the same mathematics textbook, which is prepared by experts and taught by teachers who have natural science backgrounds. Although there are subjects and few chapters in mathematics which are different for the two streams, the students' experiences in mathematics is more or less uniform. On the other hand, there are distinct differences in students' fields of study when they join the university based on their streams. This could be a possible reason for the difference in distribution of perception across the two streams about the relevance of mathematics to their future plan of study. Given the afore mentioned fairly uniform situation relating to schooling, mathematics classrooms and the sociocultural situation, the absence of evidence for significant differences across the grade levels seems to be

acceptable. Similar explanation holds with regard to sex. The situation of female and male students in schools is changing overtime. Over the past four decades there have been affirmative actions towards increasing the number of females in learning institutions and workplaces to compensate for the historical situation that disadvantaged the female. The number of female and male students in the preparatory school is balanced. The gender gap is becoming narrow, through years, in universities as well as workplaces. The number of female mathematics teachers is now increasing. A year before the data was collected the school principal was a women. During the data collection one of the two deputy school principals was a woman. These situations might have a part in creating a balanced sociocultural context for both sexes. The levels of achievements also had uniform distributions of perceptions, probably because of the high competition to join the preparatory school and very high success rate to join the university. These students were screened by a national examination and are considered as elites of their age group. The number of public and private higher learning institutions and intake rate is increasing. This being an important success indicator for the government, it highly publicizes it on the limited number of media the country has. This data was collected about four months ahead of the national and regional elections in the country, and these were major campaign instruments for the ruling party. The students get such information both in and outside the school. They are hopeful of joining the university.

CONCLUSION

For these students mathematics has exchange value, which transcends beyond the success in joining the university. The students perceive that mathematics is useful in their intended future field of study. The absence of clear idea about their future studies and what it requires in relation to mathematics on the one hand and the lack of information about why they are learning mathematics seems to lead the students to make their own speculations or accept that it is useful based on trust. Their trust for the curriculum seems to be affected by the lack of information as well as their regards for the teacher. Besides, for most of the students the sources of information about the future use of mathematics are their teachers. The fact that there is no significant difference in the distribution of perceptions between the two grade levels is indicative of the absence of sufficient information in both grade levels. This has implications for the curriculum and/or textbook preparation as well as the teachers' role in designing the school curriculum of mathematics classrooms in Ethiopia. The students should be provided with the rationale for the learning of topics of mathematics. Though direct application problems to the students' future plan of study may be difficult to provide, it is important to inspire them by informing the rationales for their learning of the concepts (cf. Wæge, 2007). The necessary familiarization to their future fields of study with respect to mathematics needs to be done at the preparatory level. The mathematics teachers can be instrumental in enhancing the students' motivations by boosting their perceptions about the

relevance of mathematics to their future goal. Students' emotion, Identity and motivation are intertwined to each other. The former two influence one another and affect the later (cf. Roth, 2007). Popularizing mathematics, particularly, with respect to social science students needs attention. Understanding how students motivate themselves in order to engage themselves in the learning of mathematics is important. The characterizations of perceptions of relevance of mathematics have motivational effect on students engaging in mathematics. Future studies need to investigate the strengths of these characterizations as motivational factor for students.

REFERENCES

Cole, M., & Engeström, Y. (1993). Cultural-historical approach to distributed cognition. In G. Salmon (Ed.), *Distributed cognitions: Education and educational considerations* (pp. 1-43) Cambridge, UK: Cambridge University Press.

Field, A. (2009). Discovering statistics using SPSS (3rd ed.). London: SAGE Publications.

Gebremichael, A. T. Goodchild, S. & Nygaard, O. (2011). Students' perceptions about the relevance of mathematics in an Ethiopian preparatory school. In M. Pytlak, E. Swoboda, T. Rowland (Eds.), *Proceedings of Seventh Congress of the European Society for Research in Mathematics Education,* (pp. 1430-1439). Rzeszow, Poland: University of Rzeszow.

Hannula, M.S. (2006). Motivation in mathematics: Goals reflected in emotions. *Educational Studies in Mathematics, 63(2),* 165-178.

Roth, W-M. (2007). Emotion at work: A contribution to third generation cultural-historical activity theory. *Mind, culture, and activity, 14(1-2),* pp. 40–63.

Vygotsky, L.S. (1978). Mind in Society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Wagaw, T. G. (1979). Education in Ethiopia: Retrospect and prospect. Ann Arbor: The University of Michigan Press.

Wigfield, A., Hoa, L. W., & Klauda, S. L. (2008). The role of achievement values in the regulation of achievement behaviors. In D. H. Schunk & B. J. Zimmerman (Eds.), Motivation and self-regulated learning: Theory, research, and applications (pp. 169-195). New York, NY: Lawrence Erlbaum Associates.

Wæge, K. (2007). Intrinsic and extrinsic motivation versus social and instrumental rationale. In D. Pitta-Pantazi & G. Philippou (Eds.), *Proceedings of Fifth Congress of the European Society for Research in Mathematics Education,* (pp. 379-388). Larnaca, Cyprus: University of Cyprus.