ORIGINAL ARTICLE

An Assessment of Mathematics Classroom Teaching-Learning Process: Consistency with Constructivist Approach

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Abstract

This study was conducted on 261 students of whom 136 were from Benishangul Gumuz and 125 from Amhara region attending government secondary schools (from 9-11 graders in the 2005 academic year). They were high achieving students in mathematics and science selected from different secondary schools in the two regions for the "talented students" outreach summer program in Bahir Dar University. The objective of the study was to assess whether the learning classroom environment was compliant with constructivism. Data about the learning environment in mathematics classroom was collected using the Constructivist Learning Environment Survey (CLES). The CLES consists of five dimensions (scales): personal relevance, mathematical uncertainty, shared control, critical voice, and student negotiation, each scale having six items. In other words, the instrument contained thirty items that pupils rank via the use of a five-point Likert scale, ranging from almost never to almost always. One sample t-test was used to analyze students' responses. Results showed that the learning environment (secondary school practices in mathematics classes in Amhara and Benishangul Gumuz region) was less constructivist compared to the expected average except student negotiation. That means four out of the five key principles of constructivism were not sufficiently implemented. However, student negotiation was found to be adequate, students indicated that enough opportunities existed for them to exchange ideas. Still students indicated that they were not encouraged to reflect on the viabilities of each others' ideas.

Key Words: *Constructivism, constructivist learning environment, Amhara region*

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BACKGROUND OF THE STUDY

The theory about the nature of knowledge, how human beings learn and the conditions that best promote learning has undergone a significant change. As a consequence, there has been a paradigm shift in approaches to teaching and learning from behaviorism to cognitivism and now to constructivism (Cooper, 1993). Nix, Fraser and Ledbetter (2005) suggested that constructivism as both a philosophy and theory of learning emphasizes knowledge construction than knowledge transmission or passive reception. They also indicated that knowledge construction requires the active engagement of students. Similarly, Palmer (2005) indicated that constructivism presupposes that students actively construct and modify their own knowledge using their existing knowledge, beliefs, interests, and goals to interpret new information or in response to environmental stimuli.

Since the active nature of students and placing them at the center of the learning process is an important element of constructivism (Cooper, 1993), active learning method takes its principles from the educational philosophy of constructivism (Lynch, 2010). In Ethiopia, all teachers at all levels of the education system are required to fully implement active learning (MOE, 2010). Peer learning (a one to five student grouping) is also emphasized being implemented at all levels of our education system. Applefield, Huber and Moallen (2001) indicated that peer learning is underpinned by social constructivist learning theory. They also detailed that collaborative peer learning is a means of preparing learners to become actively involved in constructing knowledge for themselves and understanding how to use it. Hence, although not explicitly indicated anywhere, the educational reform in Ethiopia is grounded on a social constructivist epistemology.

It is actually evident from the continuous criticisms of behaviorist approaches to education while discussing about student learning. Lecturing is highly discouraged and instead group discussion is favored. Moreover, what the government is doing to improve learning parallels to the conditions suggested by proponents of the constructivist learning approaches. It has been working with promoting student-centered approach, putting students in learning peer groups, reducing class size, supplying textbooks and other materials so that to make the learning environment favorable to classroom interaction.

However, the question of how to implement classroom teaching that is consistent with a constructivist view of learning is an issue of concern (Applefield, *et al.*, 2001). Applefield and his colleagues indicated that although the perspective of constructivism has provided educators with new ways to understand learners and the nature of learning, translating it into practice has become to be a considerable challenge to practitioners. As a novel conception of learning and learner, the constructivist perspective, after all, requires educators to have a sound understanding of what it means so that to use it knowledgably and effectively.

The shift to a constructivist approach requires creating a context that helps learners to construct knowledge, and/or modify through negotiation with peers. Regarding this, constructivists suggested that effective teaching is creating effective learning environments where students are actively participating and engaging with the material (Applefield, *et al.*, 2001). That is, for students to actively engage in and construct meaningful learning, constructivists suggested that a constructivist learning environment (a favorable learning environment) should be created for them. By constructivist learning

environment, it refers to the classroom learning environment (including the physical, social, psychological and pedagogical contexts) designed based on the principles of constructivism (Zualkernan, 2006).

Constructivists claim that students should find personal relevance in their studies, share control over their learning, feel free to express concerns about their learning, view science as ever changing, and interact with each other to construct or modify knowledge (Taylor, Dawson, & Fraser, 1995; Taylor, Fisher, & Fraser, 1997). This implies that the teacher should make the subject relevant to the students' world outside of school by connecting the subject with students' life experiences, engage them in reflective negotiations with each other by providing opportunities to explain and justify their newly developing ideas and to reflect on the viability of their own and other students' ideas, invite them to share control of the design, management, and evaluation of their learning, empower students to express concern about the quality of teaching and learning activities and provide opportunities for students to experience the uncertain nature of knowledge (Aldridge, Fraser, Taylor & Chun, 2000).

Borich and Tombari (1995) suggested that, in a constructivist classroom, the teacher's role is to facilitate and guide students by asking questions that will lead them to develop their own conclusions on the subject. Similarly, Applefield, Huber and Moallen (2001: 51) suggested that the role of the constructivist teacher is to "stimulate thinking in learners that result in meaningful learning, deeper understanding and transfer of learning to real world contexts." Richard (1991) as cited in Simon (1995) asserted that the teacher should design and provide tasks and projects that initiate students to ask questions, pose problems and set goals. Simon has indicated that to help students to become active learners, teachers should structure plans to guide exploration and inquiry. He further suggested that teachers must lead students through questions and activities to discover, discuss and verbalize knowledge.

Applefield, et al., (2001) indicated that constructivist learning theory posits that learning always builds upon prior knowledge and learning is enhanced when a person sees connection between current learning and previous knowledge (including students' out of school experiences), potential implications, applications, and benefits. They further indicated that in the social constructivist classroom, students work primarily in groups and learning is interactive and dynamic; there is a great focus and emphasis on social and communication skills, as well as collaboration and exchange of ideas. They therefore recommended that effective teaching should allow students to talk and listen, read, write, and reflect as they approach course content through problem-solving exercises, simulations, case studies, role playing, and other activities-all of which require students to apply their previous knowledge and/or what they are currently learning.

Aldridge, Fraser, Taylor and Chen (2000) conducted a cross national study on 1081 grade 8 and 9 students in Australia and 1879 grade 7 and 8 students in Taiwan using the constructivist learning environment survey, a questionnaire with five scales originally developed by Taylor and Fraser (1991) to measure students' perceptions of the extent to which

constructivist approaches are present in classrooms (the questionnaire has been explained in the instrumentation section). Thao-Do, Thi Bac-Ly and Yuenyong (2016) conducted a similar study on 335 physics teacher education students in Vietnam. Except the shared control scale, the mean score for each of the rest scales in Australia ranged between sometimes and often. The range of mean scores in Taiwan follows the same pattern with that of Australia except the critical voice scale which is between seldom and sometimes. The mean scores for each scale in Vietnam follow a similar pattern with Taiwan. Although they have differences, the three countries somehow emphasize constructivist learning environment, their classroom learning environments were consistent with the constructivists'.

Statement of the Problem

Constructivism assumes that for learning to occur collaborative social interactions and context are necessary (Applefield, *et al.*, 2001). They suggested that social interaction through questioning and explaining, challenging and offering timely support and feedback facilitates understanding. Thus in order to teach well, teachers are expected to make the classroom atmosphere more interactive and provide contexts; understand the mental models that students use to perceive the world and the assumptions they make to support those models. Could it be possible to create such classroom learning environment in our secondary schools?

If teachers in our secondary schools are practicing the constructivists' learning theory, they must invite, encourage and provoke students to experience the world, empower them to ask their own questions and seek their own answers, challenge them to understand the world's complexities, and enquire uncertainty (Brooks and Brooks, 1999). If that is the case, the classroom practices should be consistent with the principles of constructivism. In other words, teachers will create a constructivist learning environment in their classrooms. However, presumption in this or that way will not be helpful unless investigation is conducted about what actually is happening in the classroom.

The traditional approach (direct instruction or simply called the lecture method) was the most widely used instructional strategy for a long period in our school systems as it is true throughout the world. Hence, it is legitimate to presuppose that our teachers face a problem to escape from the long lived behaviorist influences and apply constructivist strategies. It is also worth mentioning the researcher's experience that in the pre-service undergraduate programs, teachers themselves are not educated in the constructivist settings and even their theoretical background about the perspective is questionable. Moreover, becoming a teacher who helps students to search rather than to follow is challenging.

Thus, the extent to which the key principles of constructivism are applied in the classroom (the extent to which the constructivists approach influenced the everyday classroom practices) need to be supported by empirical evidences. Therefore, the main purpose of this study is to assess the degree to which mathematics classroom learning environment is consistent with the key principles of constructivist approaches to learning in secondary schools of Benishangul Gumuz and Amhara Regions. Thus, based on the arguments above, the following question was answered at the end of the research process.

> Is the classroom learning environment in secondary schools of

Amhara and Benishangul Gumuz Regions consistent with the constructivist epistemology?

Significance of the Study

While implementing the constructivist approach to education, it is a paramount importance to assess its effectiveness for policy makers, teachers, students and other educators so far they are concerned with the process of education. That is either to change our educational approaches or to continue at least by providing help for teachers and students, this research will contribute for all involved in education system of Ethiopia by creating awareness about the current status of classroom learning environment. It will indicate whether the constructivist theory of learning is being properly implemented or practiced. The findings of this study will make teachers and students aware of their educational practices so that they will challenge their classroom learning approaches.

METHODOLOGY

Research Design: The purpose of this study was to assess the consistency of secondary school mathematics classroom learning environments with that of the constructivist learning environment in Benishangul Gumuz and Amhara regions. To achieve this objective, mixed methods approach specifically sequential explanatory strategy was employed as a research design. That is both quantitative and qualitative data were collected respectively using a questionnaire and an interview. Qualitative data were collected after five days from the completion of the questionnaire for the quantitative ones.

Sample of the Study: This study was conducted on 261 students attending summer outreach program in 2013 at Bahir Dar University. For its outreach program, a project to encourage "talented students" to pursue their future study in science and technology, Bahir Dar University fetched outperforming (better achieving) students in mathematics and science from different secondary schools of both Benishangul Gumuz and Amhara regions. Of these 261 respondents, 136 were from Benishangul Gumuz and 125 were from Amhara Regions attending government secondary schools (from 9-11 graders in the 2012/13 academic year).

Among them 175 were males and the rest 86 were females. Again, 52 were grade 9, 119 grade 10 and 90 grade 11 students. Six students were interviewed to further explain about their ratings. The respondents were selected based on their academic achievement, not through random sampling. However, better achieving students are believed to be involved in their learning and to have the required information about their respective classroom learning environment. They are also believed to be reflective about the classroom experiences than externalizing failures and responsibilities to teachers compared to those who achieve lower than them.

Data Gathering Instrument and Data Gathering Procedures: Quantitative data were collected using the revised Constructivist Learning Environment Survey (CLES), a questionnaire that assesses students' perceptions of their classroom learning environment. It consists of five scales each a 5-point scale of Almost Always, Often, Sometimes, Seldom and Almost Never, originally developed by Taylor & Fraser (1991) to monitor the constructivist approaches to teaching science and mathematics. The five scales

are "Personal Relevance", "Mathematical Uncertainty", "Critical Voice", "Shared Control" and "Student Negotiation". The 30-item questionnaire contains six items (statements) in each of the five scales about practices that could take place in a classroom learning environment. The questionnaire was translated into Amharic and pilot tested on two general secondary schools students of Bahir Dar Town with a sample of 150 students. The reliabilities of each scale were modest with no alpha values less than .5 and each item positively correlated with other items of the same scale. Moreover, the reliability of the overall scale was .76. Concerning validity, confirmatory factor analysis showed that items correlate with their respective scales and each has a factor loading not less than .3. Qualitative data were also collected through interview.

The questionnaire was administered face to face in the Bahir Dar University's auditorium. Before respondents start completing, the researcher explained the purpose of the questionnaire and assured them that it will be used for research purpose. Moreover, they were not required to indicate their identity. After five days they completed the scale, six students were interviewed by the researcher about the scales and individual items within the scales informing about the rating results. The interview data were to substantiate the responses for the scale. The findings of the qualitative data are integrated with the quantitative ones at the discussion section of the study.

Table 1: Scales of the CLES, and Their Descriptions

Scale	Scale Description	Sample Item
Personal Relevance	Extent to which teachers relate mathematics to students out of school experiences	I learn about the world outside of the school
Critical Voice	Extent to which students feel that it is legitimate and beneficial to question the teachers' pedagogical plans and methods	It is OK for me to ask the teacher 'why do I have to learn this?'
Shared Control	Extent to which students are invited to share with the teacher control of the learning environment.	I help the teacher to plan what I am going to learn
Student Negotiation	Extent to which opportunities exist for students to explain and justify to other students their newly developing ideas	I ask other students to explain their thoughts
Mathematical Uncertainty	provisional status of Mathematical knowledge	I learn that mathematics has changed over time

Data Analysis

Means and standard deviations were computed to describe the extent of the emphasis within a classroom learning environment on (1) making mathematics seem relevant to the world outside school; (2) engage students in reflective negotiations with each other; (3) teachers inviting students to share control of the

design, management, evaluation of the learning; (4) students being empowered to express concern about the quality of teaching and learning activities; and (5) students experiencing the uncertain nature of mathematical knowledge. To identify the significance of students' perceptions about the frequencies of occurrences of the key aspects of constructivism, the gathered data were analysed using one sample t-test. Moreover, data gathered through the interview have been analysed together with quantitative results.

RESULTS

The purpose of this study was to assess the consistency of secondary school mathematics classroom learning environments with that of the constructivists' in Amhara and Benishangul Gumuz Regions. That is to evaluate whether the learning environment was compliant with constructivism. Hence, the results of data analysis have been displayed in the following sequence. First descriptive statistics for each of the scales are given by Table 2, next the one sample t-test values for the scales are presented by Table 3.

Table 2: Descriptive Statistics: Means and Standard Deviations of Scales

Scales	N	Mean	Std. Deviation
Personal Relevance	261	2.26	0.38
Mathematical Uncertainty	261	2.77	0.57
Critical Voice	261	3.06	0.52
Shared Control	261	2.59	0.56
Student Negotiation	261	3.75	0.58

Concerning students' responses to the scales, as displayed by Table 2 above, the least mean score was obtained for the personal relevance scale (M=2.26, SD=0.38) indicating that classroom learning was rarely related to students' out of school experience. The next least mean value was gained for the shared control scale (mean=2.59) showing that students were less frequently invited to share control of the design, management, evaluation of their learning with their mathematics teachers.

The means for the uncertainty and critical voice scales are, 2.79 and 3.06 respectively which show that students are sometimes provided with opportunities to experience the inherent uncertainty and limitations of mathematical knowledge and they sometimes critique about the methods and approaches of their mathematics teachers. On the other hand, the largest mean value is found for negotiation scale, 3.75 showing that students are often provided with the opportunities to discuss with each other. The standard deviations for all the scales are small (ranging from 0.38 to 0.60) suggesting homogeneity among the ratings of students.

Table 3: One Sample t-test Values for the Five Scales

Scale	Test Value = 3 (Sometimes)			
	Mean Difference	Df	t	P
Personal Relevance	-0.74	260	-31.94	.000
Mathematical Uncertainty	-0.23	260	-6.32	.000
Critical Voice	0.06	260	1.96	.051
Shared Control	-0.41	260	-11.78	.000
Student Negotiation	0.75	260	20.85	.000

As indicated in Table 3 above, the t-test values are statistically significant for the four scales: relevance, uncertainty, shared control and negotiation scales. However, it is only for the negotiation scale that the mean is statistically significantly greater than the expected mean. The value for the critical voice scale is nearly statistically significant.

Major themes (Ideas and Opinions) from the Qualitative Data

The interview results were summarized based on the constructivist principles measured by each of the five scales as follows.

Personal Relevance

The results from the quantitative data imply that the contents of mathematics are perceived to be less relevant for students' real life. During the interview, students revealed that the tasks and activities in the text books are usually abstractions. Students see little or no real life application of the complex formulae and proves they learn.

Shared Control

The quantitative data suggest that students exercise less shared control in their mathematics classes. The interview data confirmed it and revealed that decisions regarding planning, teaching and evaluation are made almost exclusively by teachers. That is, students almost never experienced shared control in mathematics subjects. Students indicated that teachers consult students rarely about what should be included in their assessment. They are also very rarely invited in designing learning activities and that is in preparing some geometric figures, slide rules and some other teaching aids. They indicated that teachers are concerned to cover the content of the text books and almost never allow opportunities for them to exercise control over what they learn.

Mathematical Uncertainty

The result for the quantitative data has been supported by the qualitative data during the interview. Students perceived that mathematics is perfect. They indicated that the formulae and theorems are proved and uncertainty doesn't have a room in mathematics. The way they learn is to understand what has been discovered not the way to discover in mathematics. Teachers never showed them how axioms, formulae and theorems are developed and to try developing their on based on certain assumption as usually done in mathematics.

Critical Voice

It is not common for students to complain about the contents taught. They usually accept what teachers teach since they consider the contents in the text books prepared for them and are appropriate. However, students criticize the relevance of some mathematics contents to their classmates though they didn't directly ask their teachers. Similarly, students rarely complain about the teachers' subject matter

knowledge and their teaching methods. They sometimes complain to school principals to change teachers. For example a teacher teaching grade ten could be exchanged by another teacher teaching grade nine. They indicated that though very rarely students close classroom doors behind the teacher and resist entering and teaching them.

Student Negotiation

Compared to other scale values, the quantitative data for student negotiation showed that students have better opportunities. In the interview, students indicated that their teachers allow discussing over learning tasks. However, they indicated that the discussion is on solving text book problems following formulae and learned procedures than negotiating students' new ideas. Moreover, teachers allow a brief time and soon start demonstrating how to solve the problems.

DISCUSSION

In this study, the consistency of secondary school mathematics classroom learning environment with that of the constructivist key principles was investigated. Generally, students indicated that their mathematics classrooms sometimes or seldom reflected constructivist aspects, with the average item mean ranging from 2.26-3.75 for the key dimensions (a mean of 3 and 2 corresponds to sometimes and seldom respectively). The results of the analysis will be discussed for each of the scales in the ascending order of their mean values.

The Relevance Scale

This scale was concerned to measure the extent to which students were provided with opportunities to relate mathematics with out- of-school experience. The analysis revealed that the mean score was statistically significantly smaller than the expected mean, ($M=2.26$), $t(260)=31.94$, $P<0.001$. Compared to previous studies in Australia, Taiwan and Vietnam (with mean score 3.17, 3.30 and 3.12 respectively), this mean score is low (Aldridge, Fraser, Taylor and Chen, 2000; Thao-Do, Thi Bac-Ly and Yuenyong, 2016).

Students have reported that they have seen little connection between what they learn in the classroom and their real life experiences. This mean value would be even less than the current value if not students rated high an item of the scale that asked them how often they learn the use of mathematics in other subjects. As they indicated in the interview responses, their reply for how often they learn the use of mathematics in other subjects was not based on their classroom practice during mathematics lessons but simply because they get the application of mathematics in other subjects. In the interview they indicated that, during mathematics class, they almost never learned the application of the principles and laws of mathematics in other subjects.

Thus the result implies that students' real life experiences were very rarely used in the mathematics classroom learning activities. It suggests that authentic teaching of mathematics that connects mathematical concepts, skills and strategies to relevant real life contexts is missing. If this dimension which is relevant for the deeper understanding of mathematics and transfer of learning is missing, students will face challenge to apply their mathematical knowledge and skills to a broad range of real-world problems. Constructivists suggested that students should find personal relevance in their studies (Taylor, Dawson, & Fraser, 1995) which means that students will transfer the learning experience provided in schools to the real world (they will use skills developed in

schools to solve real-world problems) if they are provided during classroom learning with learning experiences that are similar to the real world experiences.

A review by Chen (2003) indicated that while the goal of education is to prepare students to use their skills to solve real-world problems, education is failing its task. Chen's review also indicated that the common reason is that the learning experience provided in schools is so different from the experience in the real world. Hence, it is obvious that students couldn't transfer learning into the work world.

Teaching mathematics as abstractions using symbols makes students lack interest in the subject. This is because concepts and theorems as abstractions are not observable and hence difficult to learn. Students consider their learning just as a useless puzzle or playing a game using letters, particularly x and y. However, students need to know how the concepts and strategies in mathematics relate with the naturally occurring contexts. Not just modeling concepts but the teachers are also required how the concepts relate or applied.

Shared Control Scale

The mean value for the shared control scale was (2.59). Students indicated that their mathematics lessons are slightly more than Seldom that they share control of their learning with their teachers. This result is consistent with previous studies (Aldridge, Fraser, Taylor and Chen, 2000; Thao-Do, Thi Bac-Ly and Yuenyong, 2016). It suggests that students perceived that their teachers were not sharing aspects of learning mathematics with their students. In other words, students showed that they rarely had opportunities to be involved in planning their learning including articulating their learning objectives, the design and management of learning activities, in deciding what should be included in their assessment and how they should be assessed. If students have to develop self regulation, to be accountable for their learning, however they have to practice planning about their learning and achievement.

Particularly, in the interview students' response confirmed that they never involve in setting objectives, and rarely in designing learning activities and in the determination of assessment tasks. They indicated that teachers also simply follow the text books, demonstrate the examples given in the texts, and give the text book exercises as class works or as home works. Students explained that their teachers never share designing activities and usually simply tell students the types of test formats while the test taking dates arrive. If shared control, an important dimension that encourages students to take responsibility for learning is missing, the very assumption of active construction of knowledge will be endangered.

The Uncertainty Scale

As indicated in the result section, the mean score for the uncertainty scale is 2.77 and this value was statistically significantly less than the expected mean. This result is low compared to previous studies (Aldridge, Fraser, Taylor and Chen, 2000; Thao-Do, Thi Bac-Ly and Yuenyong, 2016), in which it was greater than 3. The current result implies that it is seldom or sometimes that students learn about the uncertain nature of mathematics. That means students indicated that they learn as if mathematics is a universal endeavor that provide accurate and objective knowledge of reality. During interview students were asked about their experiences of using mathematics to obtain perfect answers to problems including the geometrical formulae. Students believed that

mathematics can provide perfect answers to problems. They accepted the mathematical rules (axioms) and theorems for guaranteed. When this question is extended to "can you find the exact area of a plot of land which has an irregular shape?" They started to hesitate and indicated that this is not because mathematics failed to give perfect answers rather it is due to the irregular shape of the plots of land that it is impossible to find the exact areas. They were also asked that why positive numbers are indicated on the right side of a number line and the negative numbers to the left. Their answer was because negative numbers are smaller than positive numbers. This response indicates that students consider conventions or human agreements as rules of mathematics.

Of the six items of the uncertainty scale, students rated the two items "I learn how the rules and theorems of mathematics were invented" and "I learn that mathematics is about creating rules and theorems" relatively high. During the interview students indicated that they neither learned how the rules and theorems were invented nor about creating new rules and theorems. When asked why they rated the two items high, students explained that it is because they merely learn about mathematical rules and about proving theorems. But learning rules and theorems is quite different from learning how the rules and theorems were created or learning how to create new ones. This type of learning couldn't help students to develop mathematical models so that to tackle real-world problems when they join the work world.

The Critical Voice Scale

The Critical Voice Scale assess the extent a classroom environment has been established in which students feel that it is legitimate to question the teachers pedagogical plans and methods, and to express concerns about any barrier to their learning. The result showed that the mean score is 3.06 which indicated that students somehow express their concern about barriers to their learning or understanding of mathematics and it is similar to the result for the study in Australia (Aldridge, Fraser, Taylor and Chen, 2000). This mean value, which is close to 3, suggests that teachers are somehow accountable for their pedagogical actions (instructional activities).

It is common that teachers invite students to ask any question concerning their learning. Students have also indicated this fact during the interview. They rather pointed out that asking why they learn every topic of the course is considered a negative thing and that it is the teacher who rarely tells why learning a certain topic is so relevant. But students confirmed that it is uncommon for them to challenge the plans, methods and strategies teachers use in the classroom. Hence, students' response for the scale is about their freedom to ask what is not clear during learning, not challenging the plans and methods of the teacher. Interviewed students also agreed that they know their freedom to ask what they failed to understand otherwise they never expected to comment on the strategies of the teacher in his/her teaching. In other words, students didn't often express their thoughts and criticisms about their learning and how it might be improved. Hence, this positive effect is not great enough to change traditional mathematics classrooms into highly constructivist-oriented ones.

The Negotiation Scale

As has been displayed in the result section, the greatest mean score was obtained for the negotiation scale. This mean score,

3.75, showed that the learning environment in mathematics classrooms emphasizes student negotiation. Students perceived that the classroom situation promotes student interaction during mathematics learning. They reported that the opportunity for negotiation with their peers occurred often. This result is greater than the results reported in earlier studies (Aldridge, Fraser, Taylor and Chen, 2000; Thao-Do, Thi Bac-Ly and Yuenyong, 2016).

Group discussion has become to be common in today's classrooms. Some educators are even arguing that active learning has been equated with group discussion (Lynch, 2010) and the researcher feels that teachers are using group discussion for topics which don't require divergent thinking. Hence, this result might not be surprising and a rather greater score may be expected for this dimension. The interview data showed that students are discussing just for the sake of discussing not to develop learning from each other. They indicated that discussion is just to understand what is provided in the textbook or by the teacher not to entertain different opinions from each student or to challenge what has been provided in the text books.

Generally, the results for the personal relevance, mathematical uncertainty and shared control scales are low (between seldom and sometimes) while the results for critical voice and student negotiation scales are modest. However, the interview data showed that there is a need to improve all results to actually create a learning environment that is consistent with the constructivist environment.

CONCLUSIONS

This mathematics classroom learning environment study combined quantitative and qualitative methods in Benishangu Gumuz and Amhara region secondary schools. Students perceived more critical voice and negotiations with peers and less personal relevance, mathematical uncertainty and shared control. In other words, there is a need to promote constructivist-oriented teaching in school classrooms, especially in terms of students' perceptions of shared control, the relevance of teaching and the uncertainty of mathematics. Overall, secondary school students in Benishangul Gumuz and Amhara regions perceived their current mathematics classroom learning environments as modest.

Although it was not the purpose of this study, the instrument validation process showed that the questionnaire exhibited good factorial validity and internal consistency reliability and thus can be used in further classroom learning environment studies. That is the questionnaire can serve as a useful means of evaluating the degree to which students felt that the principles of constructivism had been implemented in the mathematics classes.

RECOMMENDATIONS

Constructivism (particularly social constructivism theory) sees mathematics primarily as a social construct, as a product of culture, subject to correction and change. Social constructivists argue that mathematics is in fact grounded by much uncertainty. Like the other sciences, mathematics is viewed as an empirical endeavor whose results are constantly evaluated and may be discarded (Ernest, 2004). On the other hand, our students have evidenced that these are not usually practiced in their mathematics classrooms. Hence the results signal that there is a need to orient teachers with the constructivist educational theory and its classroom application.

The findings in this research revealed that mathematics teachers seldom or sometimes provide classroom learning contexts that makes content relevant to students' lives, connecting mathematics to students' out-of-school experiences and making use of students' everyday experiences as a meaningful context for the development of students' mathematical knowledge. Hence, teachers should provide task that are related to students' everyday life. Shared control could be improved through the development of formative assessment which allows students to identify and select their assignment and project topics themselves, and hence play a larger role in planning for their learning. Hence, teacher development programs should focus on such important constructivist principles. Moreover, teachers should be aware that they have to devise mechanisms to bring the real world into the classroom and integrate mathematics into authentic learning situations.

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