ORIGINAL ARTICLE

ENACTMENT OF STUDENT-CENTERED APPROACH IN TEACHING MATHEMATICS AND NATURAL SCIENCES: THE CASE OF SELECTED GENERAL SECONDARY SCHOOLS IN JIMMA ZONE, ETHIOPIA.

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Abstract

The study was initiated to assess the implementation of student-centered teaching of Mathematics and Natural Science subjects in three selected schools in Jimma and the surrounding towns. To this end, classroom observation method was utilized. Accordingly, 40 lessons of 24 teachers were observed. The observation result depicts that teachers were effectively utilizing prior knowledge of learners in starting their lessons. They were also active in making question rich learning environment. On the contrary, they were rated as poor in making classroom environment conducive for group learning. Utilization of learning materials and activities was also rated as low. Subject, school and grade wise comparison put relatively teachers teaching in Jimma University Community school, Chemistry subject and grade nine students on the top but the rest on the other end of the spectrum although there is no statistically significant differences. Based on these findings, recommendations for action including area for further research were forwarded.

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BACKGROUND OF THE STUDY

The shift from the teacher dominated method of talk and chalk use has been long since it became priority agenda for educational reform of countries regardless of their economic development. The instructional theories underlying the forerunning teaching approach was behaviorism and cognitivism. In the past, behaviorism was once the best and dominant theory of classroom instruction though currently considered as traditional. The prominent scholar in this area is B.F. Skinner (1938-1953) who claimed that human behavior is powerfully shaped by its consequences (Hofstetter, 1997). He reached on this conclusion because he believed that Psychology essentially studied about behavior (only the overt one) and that behavior was largely determined by its consequences. Therefore, for behaviorists to educate people is just to help them to modify their observable behavior. They also give undue emphasis to the teacher than the learners. They believe that it is the teacher who knows what is important and need to be learned by learners. They also claimed that knowledge is absolute and exists independently of the learners' mind (Jonassen, 1991). Hence, the task of the teacher is to teach them what is thought to be real and important by experts (including the teacher her/himself). As a result, behaviorists favor teacher-centered methods such as lecture, demonstration and so on. Behaviorism is effective in teaching new concepts and skills of which the learners have no prior knowledge as well as those tasks that require low level of cognitive processing skills (Ertmer and Newby, 1993). Put it in other word, behaviorism has insignificant contribution for teaching high order skills.

Cognitive perspective of education came into existence in response to the view of behaviorism. Unlike behaviorism it gave emphasis to the thinking processes behind the change in observable behavior. It focuses on the realms of perception, thought and memory and these are very important for learning (Hofstetter, 1997). For them learning goes beyond modifying behavior to developing strategies for learning (Brunner, 1995, cited in Hofstetter, 1997). Learning for cognitivists is understanding the meaning. This can be realized through employing teaching methods that help the learners relate the new concepts with the existing information in their mind or something they already know (Elliot, Kratochwill, Cook and Traveler, 2000; Ertmer and Newby, 1993). On other hand, teaching method that cultivates students' thinking and memorizing power such as use of advance organizers, logical order of the material from simple to complex, concrete to abstract, from the known to unknown and so on are advocated by cognitive Psychology.

In general, both behaviorism and cognitive theory in education agreed on the existence of absolute knowledge, which exists independently of human mind, and the task of education is transmitting that knowledge or information, of course using different methods of teaching, to the learners' mind. These two approaches of education were commonly called absolutist or objectivist approach (Jonnason, 1991, 1999).

Finally, the modern movement in education, constructivism, emerged in response to the view of behaviorism and cognitive psychology. The current paradigm shift [with respect to teaching and learning approach] in educational system of Ethiopia focus on all levels is the need for shift from teacher-centered, which is backed by objectivism, to student-centered i.e. constructivism. Constructivists do not believe in the idea of teaching as transmission of information from teacher to students. They also argued that the mere knowing and understanding of fact cannot be taken as learning, for such kind of knowledge remain inert i.e. it cannot be easily applied in unfamiliar contexts (Jonnason, 1999). Therefore, constructivists claim that learning takes place when learners are able to use the knowledge and skill they have constructed in unfamiliar context or in real world of work. To this end, they believe that learners should learn by doing (Jonassen, 1991). Learners should construct knowledge themselves both individually as well as in group. Accordingly, real environment and real tasks or activities should be designed and provided, which meant that the role of the teacher is limited to facilitating condition rather pouring information into the mind of the learners. However, this does not mean that the objectivist approach is not functioning nowadays. They are helping as stepping stone for the application of constructivism, for the student need prior knowledge in order to learn by doing (Ertmer and Newby, 1993). Nevertheless, being limited to the objectivist approach at the expense of the constructivist will jeopardize students' learning for application (Choi and Hannafin, 1995). Application of constructive teaching prepares learners effectively for advanced learning as well as for the world of work.

Nevertheless, the term constructivism is scant in Ethiopian lexicon including policy documents. Rather the term student-centered (innovative approach of teaching) is vividly emphasized in Ethiopian Education and Training policy (Transitional Government of Ethiopia [TGE], 1994; Deribssa, 2006), but emphasizing almost the same phenomenon. Therefore, the commonly known term-student-centered approach is used in this article.

Research problem and questions

Focusing on the Science and Technology Education is becoming a common goal for nations regardless of their developmental level (Weil-Barais, 2001) for advancement in science and technology helps as a tool for boosting the country's economic, social and political development. Teshome (2007) consolidated the forerunning ideas stressing that to be competitive in knowledge based economy, adoption, adaptation and utilization of science and technological innovations, strengthening and expanding science and technology education is imperative. The same document presents the aggressive actions taken by middle level income countries such as China, Japan, Korea and Taiwan in establishing new higher education and research institutions for science, engineering and technology education as well as expanding the existing programs. With regard to Africa countries, the Commission for Africa report recommends African countries to take specific action that strengthen Science, Engineering and Technology capacity for such knowledge and skills help countries to find their own solution to their own problem (Teshome, 2007).

Thus, currently Ethiopia has revolutionized the direction of higher education toward science and technology whereby 70% of entrants to undergraduate as well as postgraduate have been allocated to science and technology fields since September 2008. The success of producing competent entrants to Science and Technology is influenced by the extent to which secondary schools prepare students to such end. In line with this, Swail, Redd and Perna (2003) argue that production of professionals in quality as well as quantity in the arenas of science, technology and engineering will require good foundation at secondary education so that students will develop the required preliminary knowledge, skill and attitude that enable them to be successful in the profession. They went on discussing that academically less prepared students of secondary schools prefer humanities and social sciences than science and technology.

To this end, employing student-centered approach that would prepare students well for the profession is required. Many countries have already taken measures toward this end. To mention some but a few, Southern Africans have invested much for improving teaching of mathematics and science education at secondary education (Chemistry, Biology, and Physics) (Thjis, 1999; Ottevanger, 2001). Singapore has been playing the leading role, even better than the developed countries, in achievement on TIMSS for the country gave attention to the mathematics Curriculum and teaching methods at junior as well as secondary education (TIMSS, 2003).

When we come to Ethiopia, Higher Diploma Program [HDP], one-year on job training for teacher educators of all levels has been designed and provided in order to realize the implementation of student-centered approach (Teacher Education System Overhaul [TESO, 2003). Starting the change from Teacher Education Institution is a good approach for the teacher educators themselves need change in order to play a front line in implementing the change envisaged (Fullan, 2001, Day, 1999). Although HDP or other well organized staff development training has not been yet provided for Secondary School teachers, Continuous Professional Development (CPD), Teachers Development Program (TDP) and School Improvement programs (SIP) are there to escalate teachers teaching repertoire (MOE, 2005).

Country wide comprehensive study of the implementation of student-centered approach in Primary schools of Ethiopia was already conducted and the conclusion drawn from the study viewed that the implementation was unsatisfactory (Deribssa, 2006). Critical analysis on teaching with Plasma Televesion both at the country level (Getnet, 2008) and Practicum sites of Jimma University were also conducted (Kassahun and Zelalem, 2006). These studies came up with numerous limitations of teaching with plasma television.

However, there are schools in Jimma Town and the surroundings, which were using conventional face-to-face instruction and similar studies have not yet been conducted on. Hence, they were the target of this study.

Therefore, on the basis of this background, this study was initiated to investigate the implementation of student-centered approach in teaching Mathematics and Natural Sciences in selected general secondary schools found in Jimma town and the surrounding. To this end, the following research questions guided the investigation:

- How effective are the utilization of the student centered approach in the teaching of Mathematics and Natural Sciences in the selected schools?

- Are there differences in implementation of student-centered approach across subjects, schools and grade levels?

Objective of the study

Generally, this study attempted to assess the enactment of student centered teaching in Mathematics and Natural Sciences of General Secondary Schools in Jimma town and the surroundings.

Specifically, the study tried to;

- Describe the extent to which student-centered methods utilized in teaching Mathematics and Natural Science subjects.
- Determine if there is a variation across the subjects in the enactment of each component of student-centered approach.
- Specify if the application of student centered teaching varied across the schools and grade levels.

As the significance of the study is one of the issues of concern the output of this study and the recommendation to be drawn particularly will have multiple benefits either directly or indirectly in fostering the philosophy of Jimma University, which aims at strengthening bond between the university and the community (Jimma University, 2006). Accordingly, this condition may pave ways for the university to take part in intervening problems pinned by the study. The study is also hoped to benefit the school teachers so that they can revisit their teaching methods. The administrators of the school may also utilize the finding in taking administrative measure. These all are geared toward enhancing students' learning of Mathematics and Natural Sciences that pave ways for preparing competent entrants to the university's Science and Technology education.

Last but not least, the study might help as a stepping stone for those experts who want to carry out further investigation in similar arena or for those who want to design and implement intervention action.

The study is based on the following theoretical frameworks explicit to the student-center learning approach. Different literatures on student centered approach and related articles with similar topics were assessed in order to set framework for the study. These are Yore (2001); Saleh (2005); Cohen (1994), Jonassen (1991; 1999); Rodriguez (2000); Ertmer and Newby, (1993); Jenkins (2003); So (2002); EQUIP (2006), Deribssa (2006). As a result, the following framework was set and the investigation was done from that side.

A. Using students' existing knowledge.

It has been mentioned in the introductory part of this paper that student centered approach emphasize learning by doing. However, students learn by doing if and only if they have prior knowledge about the contents to be learned. Therefore, teachers need to link the new lesson or their teaching to what the learners already know. The teacher can ensure these principles by being aware of the students' prior knowledge; eliciting students' idea before presenting the new one or before making them study ideas from text books, challenging students' initial ideas and finally making the new idea accessible to students. On other hand, the teacher may switch on the students' brain by telling them the learning outcome or the structure of the lesson.

B. Encouraging students to generate explanations and alternative interpretations

According to constructivism, truth is not absolute rather relative. The same phenomenon is perceived differently by different people. Each student refines their thought or knowledge of the phenomenon when they reflect their idea and receive feedback from the teacher or their classmates, which result in internalizing the fact under investigation. To this end, the teacher needs to arrange conditions so that students learn by observing, describing, explaining and interpreting the phenomenon. Besides, teachers should probe students' response for clarification and justifications as well as leading students to explain contradictions and misperceptions and thereby reconcile the ideas.

C. Using discussion provoking questions.

Constructivist teaching needs a question rich learning environment that provokes discussion among students or student-teacher discussions as well as reflection by individual students. This can be done if the teacher uses more of open-ended questions that elicit multiple and contradictory responses; use questions based on students' response; accept and value students' response and suggestions

D. Use materials and activities

Constructivism has the notion that students learn for understanding/application/ when they learn using the tools/ materials that the expertise in the concerned area are using and perform the real activities. Moreover, provision of materials and activities for learners helps them to test their ideas or the theoretical part of the lesson.

E. Providing classroom environment conducive for discussion/ group work

Modern learning theory, constructivism, believes that learning doesn't take place in social vacuum. Students should learn from each other just as they do from teachers. They need to scaffold each other learning which has dual purpose both for the elaborator and the receivers. The elaborator deepens his/her knowledge as he/she gives explanation on the issues while the receivers benefit from the explanation given. For that matter the teacher needs to facilitate discussions among students, between students and the teacher him/herself, provide group work where interdependence among students is high, and use strategies that keep students remain on work in the absence of the teacher.

F. Providing opportunities for learners to utilize new ideas/and to process information.

Learners internalize and apply the new knowledge in a new situation if they get chance to think and play with the new information. By and large, students will learn for application if they get a chance to go beyond the current lesson. The teacher can realize this notion by helping students relate the current teaching with the previous one; apply new knowledge to real-life problem. Provision of further reading materials, assignment that lead them to take idea further, giving case related problems and the like will help in relation to the later mentioned idea.

In general, this study analyzed the enactment of student-centered approach of teaching in general secondary education using the aforementioned components of student-centered approach of teaching.

METHODOLOGY

Area of the study: The study covers general secondary schools which were nearby the university and those that were currently utilizing the face to face instruction. In short, the following schools were included in the study: Jimma University Community Schools (JUCS), Yebu Secondary School and Bilida Secondary School.

Study Design: A cross sectional design using quantitative study methods were used in order to assess the application of student-centered teaching in the selected general secondary school. Classroom teaching observation with the help of classroom observation checklist was used to assess application of student-centered teaching in line with the framework set.

Source of data (population of the study): All teachers teaching Mathematics and Natural Sciences (Chemistry, Biology and Physics) were subjects of the study.

Sampling techniques and procedures: A class of one teacher for each course/subject at each grade level was identified and observed. Where the same teacher was teaching both grades (grades 9 and 10) only one class was observed. Similarly, where there were more than one teacher assigned to teach a course for a single grade level, simple random sampling (lottery method) was used to identify the would be observed teacher. In general, since there were four courses to be observed, two grade levels, and three schools had to be studied, and each teacher was observed twice causes for a maximum of 48-classroom observations expected. However, since in most cases the same teachers were assigned for both grade levels and classes of grade ten students were dismissed while the data collection process was in progress, a total of 24 teachers had to be observed whereby 16 of whom were observed twice.

Study variables: The independent variables were the schools, the courses themselves and the grade levels. Thus, the dependent variable was the enactment of student centered teaching.

Instruments for data collection: Literature showed that application of teaching skills in general and application of training skills into real life class assessed better through classroom observation (Thjis, 1999 and Ottevanger, 2001). Therefore, since the intention of this study is to assess the application of student-centered teaching in the class of mathematics and natural science courses, classroom teaching observation checklist was used as a tool for data collection. For that matter, observation checklist was developed taking into consideration the framework set for the study.

Data quality control mechanisms: Information about the appropriateness of observation tool was checked at two levels. First comments were solicited from experts and then necessary amendments were made accordingly. Secondly, in order to ensure common understanding between data collectors, two data collectors observed the same classes, took notes and filled in questionnaire together discussing what they had observed. This discussion helped them to come on board as per the essence of each item as well as the expected behavior in order to assign a value. This was done until the two observers came to consensus. This would minimize personal bias that could happen if only one person were to observe the class.

Moreover, an attempt has been made to observe the same teacher twice and the average result used in order to minimize the bias.

Data analysis: The collected data was checked, coded and fed to Statistical package for social sciences (SPSS) version 12.0.The data was checked again for inconsistencies and missing values. Accordingly, frequency distribution with tables was prepared for each variable and appropriate percentage and rates were calculated. The data were relatively compared school wise, subject wise and at grade levels. Finally, one way ANOVA was used to check for the existence of significance difference among schools, subjects and grades across the different components (indicators) of student-centered approach.

Ethical issue: The study was conducted based on the consent of the school community explaining the objective of the study which was purely academic, and of course supported by the official letter of the University.

RESULTS

Background of the participants: A total of 24 teachers were observed teaching the four subjects i.e. Mathematics, Physics, Biology and Chemistry in three schools: Yebu, Bilida and Jimma University Community School (JUCS). From these 24 teachers 16 (67%) of them were observed twice during different lessons and at different times, making a total of 40 observations (16 of them twice and 8 of them once due to schedule mismatch). Out of the 24 teachers, only one of them was female. Moreover, 15 (63%) of teachers were observed teaching grade nine while 9 (37%) of them were teaching grade ten classes.

The age of participants ranged from 21 to 59 years at an average of 33.75 with the *st.d= 11.4*. Likewise, the teaching experiences of teachers ranged from 2 to 23 years service with an average of 10.29 service years *(st.d=8.1)*

Regarding educational qualification of these teachers, 14 (58%) of them were BSC/B.ED degree holders, 10 (42%) of them were diploma holders though some of them were attending summer in-service program to upgrade their educational status. Looking across schools, equal number of degree holding teachers (four) went to Yebu and Bilida whereas the rest six teachers were from JUCS. Likewise, four and two of the diploma holders were from Yebu and Bilida, respectively.

As for the training background of participants, many of them 20 (91%) have gone through teacher education system whereas about 4 (17%) of them did not. Among those who had undergone teacher education system and were these exposed to pedagogies, 45.5% of them passed through the New Education and Training Policy of Ethiopia issued in 1994. Being asked if they had ever participated in on-the-job training, majority of the respondents 18 (75%) responded negatively while 5 (22.7%) of respondents responded that they got the opportunity.

Table 1: Student population in observed classes

	min	max	mean	St.d
Female	3	33	18	6.9
Male	2	41	21.33	39.33
Total	8	74	39.33	14.00

From the 39 classes observed the range of student population per class was 8 to 74; the female ranged 3 to 33 and the male from 2 to 41. The mean of these student population per class was 39.33 (*st.d*=14). The means for female and male students per class were 18 & 21.33, respectively. However, it must be noted that the figure shows not exactly the number of students assigned in that class but students who attended the class during observation.

Classroom observations results

All the 24 high school teachers under this study were observed while conducting classes. The focus of the observations was to see if they were making their lessons student- centered. To this end, six different components of student-centered learning were identified (see the framework of the study). Again under each components of student centered teaching, items addressing active learning activities were sorted to serve the observation as a checklist. The checklist was prepared using rating scales: strongly agree, agree, slightly agree and No (not implemented). Accordingly, the first three scales stood for YES although the degree differs. As a result, the first two scales (strongly agree and agree) were taken as the correct implementation of the required behavior. In the same sequence, as its name implies, the last scale was used to denote the absence of the indicated behavior.

As indicated in the background section above, 16 (67%) were observed twice which was done as planned while 8(33%) were observed once due to some constraints. Taking the average of the rates of those observed twice and the single rate of those rated once the analysis was done at different levels. First the crude means of the average of the items of each of the six categories of the class activities were summarized so as to see the general trends in the implementation of student centered learning. Then, comparisons across subjects, schools and grade levels were followed.

The overall assessment of student-centered approach implementation

1. **The teacher uses students existing knowledge**.

   Under this category, taking the rating scale "strongly agree" and "agree" as indicating an acceptable state of the enactment of the required behavior, 69% of them were observed using the existing knowledge of students.

   Under this category, four specific items were used for observation. Accordingly, 78% of the teachers were observed beginning the lesson by involving students in talking about the last knowledge, skill and concept while 66.6% of them elicited students' idea before presenting their own ideas or the study part from the text, 58.3% tried to challenge initial ideas of students, and 75% linked the new idea/the lesson with prior knowledge of students. All these rates would have increased by 4 or 8 percents if the rate "slightly agreed were involved".

2. **Encouraging students to generate explanations and alternative interpretations**.

   The aggregated average (the mean of the means) of this category showed that the classroom performance of the 52% of teachers teaching mathematics and natural science courses were rated as successfully encouraging students to generate explanation and alternative interpretation.

   Five specific student-centered class activities were involved for observation under this category. Looking the rate of observation of each of these activities; 62.7% of the teachers were making students to observe phenomenon, 62.5% describing the phenomenon, 54.2% students generating explanation and interpretation of the phenomenon, 54% of the delivery probed students for their responses; and only 26% of the observation confirmed that students were seen explaining contradictions and misconceptions.

3. **Using discussion provoking questions.**
   Again at an average, 62.5% of this category were rated for sufficient implementation (agree & strongly agree). Like others there were four specific activities under this category. Specifically, 70.8% observation was seen as correctly implemented. Regarding the use of questions rich learning environment, 60.8% of observations confirmed the practice of raising questions based on learners' response, 50% of observation showed that students were encouraged to explain their questions and justify their responses; while 72.2% of the observation implied that students' questions were accepted and valued.

4. **Using materials and activities**.
   In this category 51% of the lesson observed witnessed the appropriate implementation (considering the rate of agree and strongly agree) of student centered learning as per the use of the activities and materials involved. Three specific items were involved in measuring the implementation of this category. Thus, 47.8% of the observed classes showed that students work with the materials and activities, 54.6% implied students work independently with minimum help form their teacher, 52.2% the materials/ activities students learn with authentic/highly stimulated materials.

5. **Conducive classroom environment for discussion**.
   This category was represented by four specific activities whereby the average rate for the correct implementation of the activities was 36 %. The rates for the specific items under it were observed as appropriate implementation (agree & strongly agree) where students freely forwarded their ideas and discussed with their teachers (52.5%), students freely forwarded and discussed with each other (25%), students remained in their group work while the teacher was not around (45.4%), students help each other on the work they were given (22.6%).

6. Providing opportunities for learners to utilize new ideas.

The rate of observations for the successful implementation of this category was 46% (agree & strongly agree) which would have been increased to 79% if “slightly agreed” was to be considered. There were four specific activities listed as a checklist under this category too. Accordingly, 71% observed that current teaching points were related to the previous knowledge, 47% of the observed classes invited students to apply the knowledge to the new situation/real life problems; about 46% classes were observed providing class works while provision of home work and assignments accounted only for 13%.

Subject wise comparison of student-centered approach implementation

The crude result as per implementation of student-centered approach in teaching of Mathematics and Natural Sciences were presented in the above part. Based on that, the output from subject wise comparison as per the implementation of student-centered teaching is presented hereunder.

Table 2: Subject wise comparison of the implementation of student-centered approach

Activities of the teacher under observation	Subject			
	Math (n_1 = 8)	Physics (n_2 = 4	Chemistry (n_3 =6)	Biology (n_4 =6)
The teacher using students existing knowledge at the beginning of the lesson	62.5%	75%	83.3%	50%
Encourage students to generate explanations and alternative interpretation	62.5%	25%	66.7%	33.3%
Using discussion providing questions	62.5%	75%	66.7%	50%
Uses materials and activities	37.5%	50%	66.7%	33.3%
Conductive classroom environment for discussion/group discussion	25%	25%	-	33.3%
Providing opportunities for learners to utilize new ideas	50%	50%	50%	33.3%

Thus, as depicted by table 2, 83.3% of the chemistry teachers basis their teaching on the existing knowledge of learners while starting the lesson followed by Physics teachers (75%). Mathematics (62.5%) and Biology teachers (50%) were observed while utilizing moderately students' existing knowledge in stating lessons.

In encouraging students to generate explanations and alternative interpretations, the highest percentage went to Chemistry (66.7%) and Mathematics (62.5%). On the contrary, Physics and Biology teachers were unsatisfactorily represented with 25% and 33.3%, respectively.

The highest rate in utilizing discussion provoking questions was observed in physics classes (75%) and then 66.7% chemistry followed by 62.5% in mathematics. Regarding the use of materials and activities, all subjects, except chemistry (66.7%), were observed to be low. Similarly, almost in all subject areas conducive classroom environment for discussion were not observed and it even went to the level of zero in Chemistry.

Coming to provision of opportunities for learners to utilize new ideas, all subject teachers were rated as moderate (50%) except those who were teaching Biology that went below the average (33.3%).

Implementation of student-centered components across the selected schools

In order to compare implementation of each component of student-centered approach in teaching Mathematics and Natural Science courses, the rating scale 3 = strongly agree, 2 = agree, 1= slightly agree and 0=not at all were used. However, since the aggregated averages of averages were required, intervals of the scales were used. Accordingly, < 1 was used to represent almost the absence of the practice, $1 \leq x < 2$ represented the slight presence of the required behavior, $2 \leq x \leq 3$ stood for the combination of "moderately agree" and "strongly agree" on presence of the behavior envisaged. Furthermore, the six major components for student centered indicators listed in tables 2 are correspondingly designated ob1 to ob6 for the following two tables comparing them school wise (table-3) and grade wise (Table-4).

Table 3: Comparison of implementation of student-centered components by school

	Scale	Yebu	JUCS	Belida	T
	< 1	1(12.5%)	3(30%)	2(33 %)	6(25%)
Ob1	1 ≤ x < 2	1(12.5%)	-	1(17%)	2(8%)
	2 ≤ x <3	6(75%)	7(70%)	3(50%)	16(77%)
	Total	8(100%)	10(100%)	6(100%)	24 (100%)
	<1	1(12.5%)	3(30%)	3(50%)	7(29%)
Ob2	1 ≤ x < 2	4(50%)	-	1(17%)	5(21%)
	2 ≤ x ≤ 3	3(37.5%)	7(70%)	2(33%)	12(50%)
	Total	8 (100%)	10(100%)	6(100%)	24(100%)
	<1	1(12.5%)	3(30%)	2(33%)	<1
Ob3	1 < x < 2	2(25%)	0(0%)	1(17%)	1 < x < 2
	2 ≤ x ≤ 3	5(62.5%)	7(70%)	3(50%)	2 ≤ x ≤ 3
	Total	8(100%)	10(100%)	6(100%)	Total
	<1	3(37.5%)	2(20%)	2(33.33%)	7(29%)
Ob4	1 < x < 2	2(25%)	2(20%)	2(33.33%)	6(25%)
	2 ≤ x ≤ 3	3(37.5%)	6(60%)	2(33.33%)	11(46%)
	Total	8(100%)	10(100%)	6(100%)	24(100%)
	<1	4(50%)	3(30%)	3(50%)	10(41.5%)
Ob5	1 < x < 2	2(25%)	5(50%)	2(33%)	9(37.5%)
	2 ≤ x ≤ 3	2(25%)	2(20%)	1(17%)	5(21%)
	Total	8(100%)	10(100%)	6(100%)	24(100%)
	<1	2(25%)	1(10%)	2(33%)	5(21%)
Ob6	1 < x < 2	4(50%)	3(30%)	1(17%)	8(33%)
	2 ≤ x ≤ 3	2(25%)	6(60%)	3(50%)	11(46%)
	Total	8(100%)	10(100%)	6(100%)	24(100%)

Obi : observation number i= 1 to 6 listed in tables 2 and 3

In all the three schools 16 (67%) teachers were observed successfully using the students existing knowledge while starting lessons (ob1). From these JUCS teachers showed the highest 70(70%) and then Yebu 6 (60 %).

Coming to activities in encouraging students to generate explanations and alternative interpretations (ob2), 50% showed satisfactory performance in the three schools where the share for not using at all accounted for 7 (29%). Bilida School is the poorest performer at a rate of 50% being followed by Yebu. When it comes to proper implementation of the above school wise went to JUCS 70%.

The next category of activities for active learning was using discussion provoking questions (ob3) and 15 (62.50%) performed appropriately. School wise still 70% JUCS) teachers performed relatively higher than the other two: (62.50% Yebu and 50% Bilida.

Regarding utility of materials and activities (ob4), only 11 (46 %) showed successful performance. School wise the upper hand went to JUCS 60%, while the others were still performing not to the required level.

The fifth section (ob5) of the class activities under observation was whether there were conducive class room environment for group discussion. In this case the majority 19 (79.17 %) were not in general successful. School wise, teachers of all schools performed under average.

Providing opportunities for learners to utilize new ideas was the next category of class activity targeted for observation (ob6). The success 11 (46 %) and the failure 13 (54.17) of this activity was almost closer to each other. School wise the JUCS showed this activity at higher rate 60%.

Comparison by grade levels

Table 4: Comparison of implementation of student-centered components by grade levels

	Scale	Grade 9	Grade 10	T
	<1	1(7%)	5(56%)	6(25%)
Ob1	1 < x < 2	0(0%)	2(22%)	2(8%)
	2 ≤ x ≤ 3	14(93%)	2(22%)	16(67%)
	Total	15(100%)	9(100%)	24(100%)
	<1	2(13%)	5(56%)	6(25%)
Ob2	1 < x < 2	2(13%)	3(33%)	5(21%)
	2 ≤ x ≤ 3	11(74%)	1(11%)	12(50%)
	Total	15(100%)	9(100%)	24(100%)
	<1	2(14%)	6(75%)	8 (35%)
Ob3	1 < x < 2	8(53%)	1(12.5%)	9 (39%)
	2 ≤ x ≤ 3	5 (33%)	1(12.5%)	6 (26%)
	Total	15(100%)	8(100%)	23(100%)
	<1	3(20%)	4(44.5%)	7(29%)
Ob4	1 < x < 2	2(13%)	4(44.5%)	6(25%)
	2 ≤ x ≤ 3	10(67%)	1(11%)	11(46%)
	Total	15(100%)	9(100%)	24(100%)
	<1	5(33%)	5(56%)	10(42%)
Ob5	1 < x < 2	6(40%)	3(33%)	9(37.%%)
	2 ≤ x ≤ 3	4(27%)	1(11%)	5(21%)
	Total	15(100%)	9(100%)	24(100%)
	<1	2(13%)	3 (33%)	5(21%)
Ob6	1 < x < 2	4 (27%)	4(45%)	8(33%)
	2 ≤ x ≤ 3	9(60%)	2(22%)	11(46%)
	Total	15(100%)	9(100%)	24(100%)

Obi : observation number i= 1 to 6 listed in tables 2 and 3

Comparing the teachers activities grade wise, it was the 9th grade teachers who were found properly using existing knowledge of students when introducing the lesson at the rate of 14 (93%) whereas their counterpart in the 10th grade was rated at 22%.

Still the 9th grade teachers were the highest at the rate of 11 (73.33%) in encouraging students to generate explanations and interpretation properly. On the contrary 8 (88.89%) of the 10th grade did not do it properly.

In implementing discussion provoking questions both categories of teachers (9th and 10th) were not successful at the rate of 10 (66.67%) and 7 (87.5%), respectively.

Coming to the fourth category of activities, proper utility of materials and activities, the highest went to 9th grade at the rate of 10 (66.67%) success rate; while the success rate of 10th was only 1 (11.11%) almost nothing.

When observing the existence of conducive classroom environment for discussion/group discussion, it was almost none in both grades.

Majority of the 9th grade teachers (60%) were found providing opportunities for learners to utilize new ideas. However, like in the other areas, grade 10th teachers were performing below the average.

Table-5: School and subject wise comparison of the six major component of student-centered approach by one-way ANOVA (N = 24 in all cases)

	Mean	St. dev	P- values	
			School	Subject
The teacher using students existing knowledge at the beginning of the lesson	1.97	1.012	0.163	0.567
Encourage students to generate explanations and alternative interpretation	1.53	0.897	0.373	0.287
Using discussion providing questions	1.81	0.973	0.445	0.482
Uses materials and activities	1.63	0.989	0.277	0.551
Conductive classroom environment for discussion/group discussion	1.32	0.801	0.052	0.529
Providing opportunities for learners to utilize new ideas	1.68	0.797	0.052	0.529

P=0.05

As shown by table 4, there is no significant differences among the selected schools and subjects across the different components (indicators) of student-centered approach except the 5th and 6th components (creating conducive classroom environment for discussion and providing opportunities for learners to utilize new ideas) where the p-value (0.052 in each case) are at marginal line for the given level $p = 0.05$.

DISCUSSION

This part discusses results presented in section 3 of this article linking it with existing literatures and lived experiences of the researchers. In doing so, analysis starts from the background of the participants to the classroom observation output.

On the premises that academic qualifications of teachers significantly influence their classroom teaching performance (MOE, 2005), information as per academic qualification of participants was solicited where 58% of teachers were qualified. However, this figure is below the National Educational Strategic plan projected for 2010/2011, which is 88% (MOE, 2005).

Majority of participants went through the recent Teacher Education System (91%), where paradigm shift from teacher dominated to student-centered teaching method was emphasized (TESO, 2003). However, majority of the study participants (75%) were deprived of the on-the-job training opportunities though that is crucial in enhancing student achievement through escalating teachers' competences in classroom instruction (Fullan, 2001 and Guskey, 2000).

Since the size of the classroom has direct impact on the implementation of student-centered teaching, the exact number of students who attended classes during observations were taken and the result showed that the maximum number of students in a class exceeded by far (74 students) the national average student-section ratio projected, which is 40 students per class by 2010 (MOE, 2005).

Classroom observation results, disclosed that the different components of student-centered teaching was enacted at various levels. Accordingly, using of students' existing knowledge (75%) came in first followed by teachers' use of discussion provoking questions (62.5%). On the other hand, encouraging students to generate explanations and alternative interpretations and teachers' use of materials and learning activities implemented mildly, 52% and 51%, respectively. The rest components of student-centered teaching were implemented inadequately at the rate of 46% for provision of opportunities for learners to utilize new ideas and 36% for existence of conducive classroom environment for discussion. The detailed analysis of the implementation of each of these components is presented as follows. This implies that teachers were active in making their lesson student-centered at the beginning of the classes but fall back to the traditional teacher-centered approach thereafter. It seems that this has become a tradition in Ethiopia as a study on classroom teaching of instructors working in the Faculty of Education, Jimma university, showed the same trend (Adula, 2008).

It has been shown that teachers included in the study revealed an active use of students' existing knowledge in beginning their lessons. Taking a close look at the implementation of this principle across subjects, and schools, and grades levels, all were doing well except for the teachers observed teaching grade ten students, which was rated below the average (22%). In general, this implies that participants were successful in switching on the mind of their learners in beginning their classroom teaching. Literatures on classroom teaching also stressed the need for motivating students since motivation is a key for making learning continuing, improving, inspiring and enjoyable process (EQUIP, 2006; Adula, 2008; Jenkins, Breen, Lindsay & Brew, 2003).

Like using of existing knowledge, participants were active in using discussion provoking questions. This was following similar trends across all selected subjects, schools and grades. However, as it is to be argued later, questioning techniques were targeting smooth student-teacher interaction rather than student to student interaction. However, ability to use questions wisely in classroom teaching is one of the great success teachers proud of since that is the way by which teachers elicit students' opinion, ignite their intuitive thinking of thus leading them to refine their thought.

It has been stated that the participants of the study were mildly encouraging students to generate explanations and alternative interpretations (52%). When this seen closely against the basic items used for checklist, teachers poorly encouraged students to explain contradictions and misconceptions (26%), though that is basic for preparing students for science discipline through equipping them with the skill of creativity as well as cultivating their abstract thinking ability (Jonnason, 1991; 1999). However, other parameters such as letting students observe, describe, generate explanation and interpretation of phenomenon, were realized moderately. Despite the fact that participant teachers attempt of encouraging students to generate explanations and interpretation in general was labeled as moderate, there is a difference when the same data applied at a courses, schools and grade levels. Accordingly, teachers teaching Mathematics (62.5%), Chemistry (66.7%); and teachers working in JUCS and grade 9^{th} as well were pioneer in pushing students to generate explanation and interpretation. On the contrary side, performances of participants teaching Physics, Biology, grade 10 students and teachers teaching in Yebu and Bilida Schools were reported to be below the average.

Like the forerunning component of student-centered teaching, participants showed weak performance in using materials and learning activities (51%) with an emphasis on letting students independently work with the learning materials, as well as with the authenticity of the materials. Comparing across subjects, Chemistry teachers were doing well (66.7%) followed by Physics teachers (50%), while that of Mathematics and Biology teachers were rated unsatisfactorily. Moreover, schools and grade wise comparison put JUCS (60%) and grade ten (67%) on the top where as the rest were rated as performing bellow the average.

Using of materials and authentic learning activity is at the heart of Mathematics and Science discipline. If students are provided life related activities and exposed to learning materials or instruments experts are using, students can be motivated and internalize basic science concepts and skills, which have profound effects on their later professional life. Otherwise, if everything becomes theory-dominated, then students may even hate hard science at all, which may hamper the country's agenda i.e. science and technology based expansion of higher education (Teshome, 2007).

In student-centered teaching, students need to be provided with opportunities of utilizing new concepts or skills so that they can master it to the required level. However, it is only 45% of the participants that were observed rendering such opportunities. Among the activities used as indicators for this component, relating current teaching to the students' prior knowledge is satisfactorily enacted at the rate of 70.8%. This is a prerequisite for student-centered teaching according to constructivists since students need to have some background knowledge in order to learn by doing (Newby and Ertmer, 1993). By and the large, indicators such as inviting students to apply the knowledge to unfamiliar situation, provision of class work as well as homework or assignment were under reported. Particularly, teachers use of homework or assignments was reported to be insignificant i.e. 13%. A growing body of literatures stressed the role of providing home work in providing opportunities for learners to practice what they have learnt in the classroom so as to master the concept/skill (Choi, & Hannafin, 1995)). Providing an assignment goes beyond letting students practice what they have learnt in a class to using of the learnt knowledge in an authentic environment. Thus, in preparing students not only for today's world but for a society that is aspiring to develop in the following decades, assignments should be provided for students in a progressive manner.

Nevertheless, the aggregated subject wise comparison of the enactment of providing opportunities for learners to utilize new idea showed that all subject teachers moderately (50%) utilized the principle except Biology teachers who were rated at 33.3%. Similarly, school wise comparison showed that except Yebu others were showing relatively good performance. Likewise, teachers teaching grade 9th students showed better performance compared to their counterpart teaching grade 10.

Educational Psychologists believe that learning doesn't take place in a social vacuum (Cohen, 1994). Particularly constructivists, who were favoring student-center learning with the assumption that learning takes place when students construct knowledge through interacting with the immediate environment including learning materials, underscored the value of collaborative learning since that gives opportunities for learners to scaffold each others learning, refine own thought as a result of reflection from friends, broaden their understanding through elaborating for friends, and benefited from elaboration given (particularly for slow learners) (Cohen,1994; Saleh, 2005). Besides knowledge construction, collaborative learning aids students to develop teamwork skills, which is fundamental for their employability and national economic performance (Jenkins, Breen, Lindsay & Brew, 2003). However, attempts made by the teachers who participated in this study were very low, to the extent that those teaching chemistry extremely performing poor in making classroom environment conducive for group discussion. Students of the observed teachers were rarely freely communicating idea with each other, and rarely help each other as well. The only positive aspect evidence was teachers' ability to encourage students freely to communicate with them. Thus, it would have been nice had it been that teachers were encouraging students to communicate with each other as they did to communicate back with them.

CONCLUSIONS AND IMPLICATIONS

Although the majority of the participants had gone through the teacher education system, qualified teachers were not up to the required standard set for secondary education. Similarly, teachers of secondary school Mathematics and Natural Sciences of the selected schools did not have access to on-the-job pedagogical training that would help them to update their existing repertoire.

The study showed that implementation of student-centered teaching varies relatively across the components of student-centered teaching, subjects, schools and grade levels. Accordingly, participants were successfully implementing the basic principle of using students' existing repertoire in beginning their lesson. Likewise, participants of the study were active in using discussion provoking questions. This was following similar trends almost across all selected subjects, schools and grades.

On the contrary, provision of conducive condition for group discussion/ collaborative work was very low in all cases in general. As a result, students in observed classes were not adequately engaged in collaborative work such as helping each other learn, and persistently working on the task in the absence of the teacher. Correspondingly, attempts made by teachers in giving an opportunity for learners to utilize new idea were insignificant. Such kinds of opportunities were usually created through relating classroom teaching to the immediate experience of students; giving home work/assignments. However, such practices were very rare in general in the selected schools.

Subject wise comparison showed that Chemistry teachers were relatively showing good performance in implementing student-centered teaching relative to others except in creating conducive environment for group discussion. On the contrary, Biology teachers were relatively poor in implementing their classroom teaching. Similarly, school wise comparison of implementing student-teaching confirmed that JUCS performed well followed by Yebu School. This may be due to the fact that the two schools were well established and have experienced teachers compared to Bilida which was established and upgraded recently by local community effort.

Across grade comparison showed that teachers teaching 9^{th} grade classes were performing better than teachers teaching grade ten students. It seems paradoxical since in most cases teachers teaching grade 10 students were believed to be reputable, well experienced as long as they are bearing responsibility for preparing students for National Qualification Examination. So, this needs further investigation.

Implications

Based on the data gathered discussion as well as conclusion part of this article, the following implications were derived in order to improve the implementation of student-center teaching in mathematics and natural sciences of the selected secondary schools

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- It has been indicated that teachers of the selected schools were hardly provided with on-the-job pedagogical training. Again, teachers' performances with the on the majority of student-centered teaching components were poor except in using of students' existing knowledge as well as making question rich learning environment. Thus, comprehensive on-the job pedagogical training that would address the prevailing constraints is required if a real change has to be made in preparing students for science discipline. As far as making classroom atmosphere conducive for classroom discussion was pinned as severe problem across all subjects, schools and grades due attention should be given to it during intervention.

- The study showed that teachers teaching grade nine surpassed in performance when compared with those who were teaching grade ten. However, in most cases well experienced and qualified teachers assigned for higher grades. So, this is a fertile area for further investigation.

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REFERENCE:
Adula, B. (2008). Application of Higher Diploma Program training skills in classroom instruction: The case of Education Faculty, Jimma University (Ethiopia). *Journal of Educational Science, 4* (1)pp, 51-72.

Cohen, (1994). Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research, 64*(1), pp. 1-35.

Choi, J.L. & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *Educational Technology Research and Development*, *43*(2), 53-69.

Day, Ch. (1999). *Developing teachers: The challenge of lifelong learning. Educational change and development Series*. London: Falmer press.

Deribssa, D. (2006). *Quality of Teaching and Learning in Ethiopian Primary Schools: Tension between Traditional and Innovative teaching-learning Approaches*. Unpublished research paper.

Elliot, S. N.; Kratochwill, Th. R., Cook, J.L. & Traveler, J.F (2000). *Educational Psychology: Effective teaching, effective learning*. (3rd ed.). McGraw-Hill.

Ertmer, P. A. & Newby, T. J. (1993). Behaviorism, Cognitivism, constructivism: Comparing critical features fro m an instructional design perspectives. *Performance improvement Quarterly*. *6*(4), 50-70.

EQUIP (2006). *Instructional skills training Manuals*. Addis Ababa: St. Merry printing press.

Fullan, M. (2001). *The new meaning of educational change* (Third Ed.). New York: Teacher College Press.

Getnet, D.B. (2008). Using “Plasma TV” broadcasts in Ethiopian secondary schools: A brief survey. *Australian Journal of Educational Technology, 24*(2), 150-167.

Guskey, Th.R. (2000). *Evaluating professional development*. Thousand Oaks, California: Crown press.

Hofstetter, F. T. (1997). *Multimedia Literacy*. McGraw-Hill.

Jenkins, A., Breen, B., Lindsay, R. & Brew, A. (2003). *Reshaping teaching in higher education: Linking teaching with research*. London: Kogan Page Limitted.

Jenkins, E.W. (2003). *Guidelines for policy-making in secondary school science and technology education:* UNESCO: Division of Secondary, technical and Vocational Education Section for Science and Technology Education.

Jimma University. (2006). A *national pioneer in community based education of higher learning. [*Brochure*]*. Jimma, Ethiopia: Author.

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development, 39*(3), 5-14.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: volume 2-A new paradigm of instructional theory* (pp. 215-239). Mahwah, NJ: Erlbaum.

Kassahun, M & Zelalem, T. (2006). Assessment on the impact of plasma television implementation on the teaching learning process of mathematics class: the case on selected practicum sites (high schools)for education faculty of Jimma University. *Ethiopian Journal of Education and Sciences, Vol 2,* No 2 , 85-127.

Ministry of Education [MOE] (2005). *Educational Sector Development Program III (ESDP III).* MOE: Addis Ababa.

Ottevanger, W (2001). *Teacher support materials as a catalyst for Science Curriculum Implementation in Namibia*. Doctoral Dissertation,

Enschede: University of Twente

Rodriguez, A. J. (2000). *Sociotransformative Constructivism: What is it and how can I use it in my classroom?* New Mexico State University, Science Education

Saleh , M. (2005). *Optimizing grouping practices in elementary classrooms. Doctoral Thesis. Chapter two, Theoretical framework*. University of Twente, Enschede. So, W.W. (June, 2002). Constructive Teaching in primary science. *Asia-Pacific Forum on Science Learning and Teaching, 3*(1).

Swail, W. S., Redd, K.E. & Perna, L. W. (2003). *Retaining Minority Students in Higher Education. Framework for Success*. USA: Jossey Bass.

Teacher Education System Overhaul [TESO] (2003). *Handbook.* Addis Ababa, Ethiopia: Ministry of Education.

Teshome, Y. (2007). *A policy White paper prepared by Education and Ministry of capacity building on undergraduate and graduate degree programs mix and student placement in the expanding higher education system in Ethiopia (circulate for comments).*

Thijs, A.M. (1999). *Supporting science curriculum reform in Botswana: The potential of peer coaching.* Doctoral Dissertation, Enschede: University of Twente.

Transitional Government of Ethiopia (TGE). (1994). *Education and training policy*. Addis Ababa, Ethiopia: Author.

Trends in International Mathematics and Science Study [TIMSS] (2003). *TIMSS assessment frameworks and specifications 2003*. 2nd Ed. US, Boston College: IEA.

Weil-Barais, W. (2001). Constructivist approaches and the teaching of science. *Prospects: quarterly review of comparative education; XXXI (* 2), 187-196.

Yare, L. D. (2001). What is meant by constructivist Science teaching and Will the Science Education Community Stay the Course for Meaningful Reform? *Electronic Journal of Science Education, 5* (4).