Level of Practices and Challenges of Metacognitive Strategies in Physics Teaching at Secondary Schools: The Case of Bako and Tibe Secondary Schools, Western Shewa Zone of Oromia Regional State, Ethiopia

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Abstract

Metacognition is thinking about thinking. It is the primary vehicle for student learning. Thus, this study aimed at examining teachers' level of metacognitive knowledge, practices of metacognitive teaching and challenges of implementing metacognitive strategies in classrooms. It considered students (grades 9 and 10), physics teachers and principals of Bako and Tibe secondary schools in the academic year of 2010/2011. Using probability proportional to size, 213 and 134 students were selected from grades 9 and 10 respectively. The total sample size was 368 (347 students, 8 principals and 13 teachers). The study was survey type guided by three research questions which were answered using the data collected through questionnaire, interview and classroom observation checklist. Cronbach's alpha, percentage analysis, Mann-Whitney U test and ANOVA tests were used in data analysis. The result showed that teachers' knowledge of cognition and level of metacognitive teaching were low or absent. The study also indicated that low level of teachers' knowledge of cognition, students' lack of metacognitive learning experiences before and the case that metacognitve strategies take large amount of time were appeared to be the main challenges of metacognitive teaching in those schools. Hence, this study suggested that teachers need professional development opportunities on metacognitive strategies.

Introduction

Origins of Metacognition

Metacognition was not known as metacognition until an American psychologist and researcher, John Flavell (1976). However, the concept has been mentioned in literature and linked to an educational context since the Greek philosopher Socrates argued that you must "know thyself" to be wise. In the 17th century British philosopher John Locke included something (ideas of reflection) he referred to as "intuitive knowledge". Little over two hundred years later, the American philosopher John Dewey spoke of "reflective self-awareness".

Then after, the term used to denote "One's knowledge concerning one's own cognitive processes and products or anything related to them and refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes, usually in the service of some concrete goal or objective." (Flavell, 1976). A recent definition describes metatcognition as "one's knowledge and beliefs about one's own cognitive processes and one's resulting attempts to regulate those cognitive processes to maximize learning and memory" (Ormrod, 2006).

Nature of Metacognition

Metacognition consists of two main components: knowledge of cognition and regulation of cognition. Knowledge of cognition refers to how much learners understand about their own memories and the way they learn while regulation of cognition refers to the control of an individual's ongoing cognitive processes.

Schraw and Dennison (1994) represented knowledge of cognition with three different types. Declarative: knowledge about self and about strategies, procedural: knowledge about how to use strategies and conditional: knowledge about when and why to use strategies.

Declarative knowledge helps to know what factors influence one's performance. Individuals with a high degree of procedural knowledge perform tasks more automatically, are more likely to possess a larger directory of strategies, to sequence strategies effectively, and qualitatively use different strategies to solve problems. Conditional knowledge is important because it helps students selectively allocate their resources and use strategies more effectively. It also enables students to adjust to the changing situational demands of each learning task.

Regulation of cognition includes planning, monitoring and evaluation. Planning helps the learners define what the problem is, and select an appropriate solution strategy while monitoring helps to check the effectiveness of the solution strategy and the third one is evaluating the end results.

Instructional Metacognitive Strategies

While there are several approaches to metacognitive instruction, the most effective ones involve a mixture of theory and practice. The learner must be given some knowledge of cognitive processes and strategies (that will be used as metacognitive knowledge), as well as opportunities to practice both cognitive and metacognitive stategies; evaluation of the outcome of their efforts is also important for the development of metacognitive regulation (Brown, 1987; White *et al*., 1999). Simply providing knowledge without experience or vice versa does not seem to be sufficient for the development of metacognitive control. Hence, it is necessary to design metacognitive activities that can be embedded into instructional contexts. In this sense, Lin (2001) suggests that the design of such metacognitive activities should focus on both cognitive and social aspects of student development, including strategy training and creation of a supportive social environment for the teaching of two kinds of content: knowledge about a specific domain and knowledge about the self-as-learner. Researchers have identified strategies that teachers can use to promote metacognition in the classroom. The following are lists of teaching techniques and self-directed strategies that have been commonly applied in classroom.

Reflective Questions and Reflective Prompts

These can encourage students to reflect on strategies that they use to perform a learning task (such as solving a problem) and explain their reasons for using those strategies. There is a difference between questions and prompts. Questions are of a more general nature, serving as a way for triggering broad metacognitive monitoring. Examples of questions are: "Now what?" or "So what?". They may help the student to reflect on the next step and make links to the previous tasks done.

Reflective prompts (also called metacognitive prompts) are more focused questions that provide a more directive help on specific aspects of the learning processes. These prompts aim at guiding coherent understanding of the domain tasks at hand and may lead to extensive inference generation (Lin, 2001).

To be effective, the prompts should use open-ended questions. For example, prompts like "Should your goals be reformed?" do not trigger as deep a reflection as "What aspects of your goal setting would you change?". The prompts should ask for specifics and examples, even if it is the case that the student is not going to write down his/her reflections (e.g. "What is a new example of ...?"). Another prompting technique consists in paraphrasing and summarizing what the student says when she/he asks for help; for example: "So what you are concerned about is how you can monitor your problem solving attempt?".

Finally, prompts can also redirect questions to learner, like "Note taking is not occurring in your study from text, should that be the goal of this stage?". Prompting has also been used to stimulate self-explanation for metacognitive development- eliciting learners' explanations and justifications through prompting can help them to draw conclusions and make inferences that can lead to increased comprehension (Chi et al.,1989).

Metacognitive Scaffolding

Scaffolding means providing support to students to bridge the gap between what they can do on their own and what they can do with guidance from others (Hartman, 2001a). Scaffolding may take the format of models, cues, prompts, hints, partial solutions, etc. The main characteristic of scaffolds is that they have to be regulated according to the amount of help the learner needs, and eventually the help should be not necessary anymore.

Metacognitive scaffolds support the underlying processes associated with individual learning management, providing guidance in how to think during learning. It might remind learners to reflect on the goal(s) or prompt them to relate the use of a given resource or tool to the completion of a task at hand. The scaffolding is intended to serve as an external model of knowledge monitoring behaviour until it is internalized. Therefore, the goal of metacognitive scaffolding is for students to become independent, self-regulating thinkers who are more self-sufficient and less teacher-dependent. It is an especially effective teaching approach for developing higher level cognitive strategies (Hartman, 2001a).

Modeling

Providing models of metacognition in everyday-life and/or school is an important strategy for developing meacognitive knowledge and skills. Modeling is often a component of scaffolding. Peer modeling is another possibility. Lin (2001) illustrates this approach with the following example: a student observe a peer engage in effective problem identification and conceptualization of principles for problem solving and by observing their peers, the student may begin to think that she/he also can be creative and an effective problem solver.

Self-questioning

Self-questioning strategies are effective ways of promoting self-directed learners. Research on self-questioning shows that questions created by the student are much more effective than questions given to the student by someone else. Self-questions such as "Have I left out anything important?" can help a student self-direct in identifying the omission of important points or examples.

The more students practice generating and using self-questions in diverse situations the more likely they are to develop the habit of self-questioning so that it becomes a skill, which is used automatically and unconsciously as the situation requires. It is important to regularly have students adapt their self-questions to the needs of the specific subject and task (Hartman, 2001a).

Thinking aloud and self-explanations

Thinking aloud is a technique of externalizing one's thought processes as one is engaged in a task that requires thinking. The thinker says out loud all of the thoughts and feelings that occur when performing a task (e.g. solving a problem, answering a question, conducting an experiment, reading through textbook notes, etc.). Teachers can use the think aloud method to serve as expert models showing students how to use metacognitive knowledge and strategies when working on a variety of tasks; for example, to let students see and hear how they plan, monitor, and evaluate their work. When the thinker-talker is the subject-matter expert, the process allows the expert to model their own thinking for students. This modeling shows how to think about the material (knowledge, skills, procedures, etc.). It lets students hear what goes on in an expert's head when a text is read, a homework assignment is attacked, study for a test is planned, an essay is written, an error is found, or a problem is solved. This modelling should involve communicating with students so that the lesson is an interactive dialogue instead of a monologue, and modelling should be gradually phased out as student competence and responsibility increase.

Self-explanation is the process of clarifying and making more complete to oneself the content of an exercise, a text, an example, etc. It is more effective than explanations provided by others, because they require students to actively elaborate their existing knowledge (Chi *et al*., 1989).

Self-assessment

Students who observe and evaluate their performance accurately may react appropriately by keeping and/or changing their study strategies to achieve their goal. Example: maximizing their grade in a course or on a test. Thus, it is desirable to engage students in activities that will help them to assess themselves and to explain explicitly what they know and do not know.

Graphic organizers

Graphic representations can be used to understand text and to solve a variety of problems. They can help students analyze text and see how it is structured. Some graphic organizers that can be used to understand text are flow charts, concept maps, venn diagrams and tree diagrams. Other graphic organizers identified found to be useful for reading text: network trees, fishbone maps, cycles, spider webs, continua/scales, series of events chains, compare/contrast matrices and a problem/solution outlines.

Background of the study

While the world is developing rapidly through the application of science and technology, students' interests in physics were diminishing at all levels of education. As a result, fewer and fewer students in Colleges and Universities selected it as their major subject (Fischer and Horstendahl, 1997). Therefore, it is becoming a must that the models of teaching physics must be reformed and improved in such a way that it can attract learners to join this field of study.

Over the past 30 years, the emphasis within the literature examining physics problem-solving has shifted away from analysis of cognitive to metacognitive (Kramaski *et al*., 2004). This is because students without metacognitive approaches are essentially learners without direction or opportunity to review their progress, accomplishments and future directions (O'Mally *et al*., 1985).

Therefore, it must be incorporated into the subject matter that students are learning. But many students may be unaware of its importance unless the processes are explicitly emphasized by their teachers.

Therefore, the model for using the Metacognitive Strategies (MS) is provided initially by the teacher, and students practice and discuss the strategies as they learn to use them (White and Frederickson, 1998). When teachers encounter difficulty in applying these strategies, their problems must be addressed on school-wide approaches to assist them in doing this fundamental work. The researcher of this study has been working as a physics teacher, in Bako Secondary School (SS) since 2005. Each year, the results of grades 9 and 10 students in physics were disappointing in that only a few students scored well. When students were asked questions requiring their conceptual understanding on examinations, only the most active students became successful while the majorities were not. However, research shows that teaching in MS has shown to improve students' understanding in physics and transfer to new settings and events (Scardamalia *et al*., 1984; White and Frederickson, 1998; Lin and Lehman, 1999). Had metacognitive strategies been implemented in physics teaching, students' achievements wouldn't have been disappointing. Therefore, the researcher assumed that a metacognitive teaching was missed in this school.

Statement of the Problem

From his meta-analysis of 395 experiments, Marzano (1998) concluded that metacognitive thinking is the primary vehicle for student learning. This conclusion had also been supported by other experimental studies (Kramaski *et al*., 2004). Sternberg (1998) also reported that students taught through metacognitive strategies are successful in school.

Despite this evidence, teaching strategies that incorporate metacognition were seldom common in classroom practice (Bransford *et al., 1999)*. This is also true in Bako and Tibe SS. There might be factors that affect the implementation of those strategies. However, to the knowledge of the researcher, generally in Ethiopia and particularly in the study area, research had not been conducted that explores teachers' knowledge of cognition. This triggered the need to conduct research in this regard to address the teachers' knowledge of metacognitive instructions, level of practices and challenges in implementing this method of instruction.

In this study, the researcher examined teachers' knowledge of cognition, practices of metacognitive teaching and challenges of metacognitive strategies in their classroom at secondary school levels particularly, in Bako and Tibe SS which were found in West Shewa Zone (WSZ) of Oromia Regional State (ORS).

Based on this aim in mind, the following basic questions were clarified in this research.

1. What level of knowledge do high school physics teachers have about metacognitive strategies?
2. What are the levels of practices of metacognitive strategies in these schools?
3. What impede teachers' implementation of metacognitive strategies in secondary school physics classroom?

Objectives of the Study

The objectives of this research were:

1. To investigate level of knowledge of metacognitive strategies amongst physics teachers in Bako and Tibe Secondary Schools.
2. To access the level of practices of metacognitive strategies in these schools.
3. To identify factors that inhibits implementation of metacognitive strategies in teaching physics.

Significance of the Study

The present study might contribute to the following.

1. It might indicate major challenges in implementing Metacognitive strategies in teaching learning activities in the school.
2. It might emphasize and promote the importance of introducing metacognitive strategies in classrooms.
3. It might also be used as basis for further research in this area.

Scope of the Study

This study was delimited in searching for level of practices and challenges of MS that teachers encountered at Bako and Tibe SS. It also investigated the level of knowledge of cognition (declarative, procedural and conditional knowledge) of physics teachers in those schools.

Limitations of the Study

Due to the shortage of time, budget and resources, this study was limited to physics teachers in Bako and Tibe secondary schools. Furthermore, metacognition was an internal dialogue and might not be directly observable. This might also limit what the researcher wanted to know about metacognitive knowledge of the participants. In addition, when the questionnaire was administered, teachers participated in this study complained at that they didn't know metacognition and unable to complete it. Then the researcher presented them with an overview of metacogniton. Some respondents didn't answer open ended questions as they didn't know what it means. Hence, the researcher doubt that the responses given by teachers to the closed ended part was correct. The absence of related research works in the field of metacognition in Ethiopia was also another limiting factor of this research. Thus the researcher had to relay mainly on the study materials and experiences of foreign sources. All these might have affected the outcome of this research.

Materials and Method

Research Design

The study was conducted at Bako and Tibe SS in Bako Tibe Woreda. Bako Tibe woreda is found in WSZ of ORS in which neither public nor private secondary schools were found. This woreda was located at 251km from Addis Ababa.

The design of the research was a survey type. There were three governmental secondary schools in Bako Tibe woreda namely; Bako, Tibe and Sheboka. Because of their proximity, the research was conducted in collaboration with students, teachers and principals working in Bako and Tibe SS. Students were required as they gave information what teachers were really practicing in classrooms. The principals also provided some challenges in the school context and also commented on the teaching practices of the teachers. The study examined what can be inferred regarding teachers' pedagogical understandings and practices of metacognitive instruction. In addition, it closely looked at the factors affecting teachers' use of MS in classroom practice.

Subjects of the Study

The subjects of the study were students (grades 9 and 10), physics teachers and principals of Bako and Tibe SS in the academic year of 2010/2011. On this regard, there were 10 and 3 physics teachers in Bako and Tibe SS respectively. By using probability proportional to size (pps) sampling method, the sample of students from each school was calculated as follow:

Let **N** be the total population of students and **n** the sample size:

$$N=1620(\text{grade9})+1020(\text{grade10})$$

$$\Rightarrow N = \mathbf{2640}$$

Then applying pps, the sample size **n** is given by: $\mathbf{n} = \frac{N}{1+N(0.05)^2} = \frac{2640}{1+2640x(0.05)^2}$

$\Rightarrow \quad n = \mathbf{347}$(Total sample of students)

Generally, the sample size of the study population was described in the following table.

Table1. Sample Sizes of the Study Populations

Group of Population	Bako SS		Tibe SS		Calculated sample size
	Total population	Calculated sample	Total population	Calculated sample	
Grade 9	1080	142	540	71	213
Grade 10	600	79	420	55	134
Physics teachers	10	10(all)	3	3(all)	13
Principals	4	4(all)	4	4(all)	8
					Total sample size=368

Data Collection Instruments

In the present study, questionnaire, classroom observation check list and interview were used as instruments of data collection. Thus, interview responses, answers to the written questionnaire and classroom observation checklist records were used as data sources. After collecting all the necessary data, the data were edited, coded, tabulated and processed in a way appropriate to answer the research questions. The quantitative data were fed in to the computer and analyzed using SPSS version 12.0 software.

Methods of Data Analysis

The purpose of this research was to study about teachers' level of metacognitive knowledge, practices of metacognitive teaching and challenges of implementing metacognitive strategies in physics teaching at Bako and Tibe secondary schools.

Teachers' responses to the 17 items questionnaire on MAI and to the 5 items open ended questions were used to answer research question one. Regarding the closed ended items, the total MAI scores for each of the three components (declarative, procedural and conditional) were expressed in averages for the total score separately and discussed.

Students' responses were described using percentage analysis for grades 9 and 10 separately. The procedures were repeated for principals. The Mann-Whitney U test was used to investigate whether there was significant difference between grades 9 and 10 responses to reach on the conclusion for research question 2.

The analysis of the checklist data involved counting the scores of individual statements for the total of 78 physics lessons and then expressing the counts in percentages. As the instrument had three sections, the start (introduction), the body and the conclusion of the lesson, each section was analyzed separately. All statements with mark 'yes' and 'no' were counted and the total was divided by the total number of statements per section. A general conclusion was reached after considering the three sections together (Akker and Voogt, 1994).

Students' and principals' responses to the 2nd part of their respective questionnaire and teachers' interview responses were used to answer the last question of this research. Since parts of the questionnaires concerning challenges of metacognitive teaching were identical for students (grades 9 and 10) and principals, they were analyzed for significant differences in their responses using ANOVA test after each of them were separately analyzed using percentage frequency of occurrences. Students' and principals' responses to the open ended questionnaire, and teachers' interview responses were used to supplement the results of the data obtained through the closed ended questionnaire.

Finally, the data from questionnaire, observation checklist and interview were organized, coded in to SPSS and analyzed. Based on the analysis of data, the results were discussed and summarized to give conclusion and recommendation.

Results and Discussıon

Teachers' Metacognitive Knowledge

The MAI average score of teachers range from 2.75 to 5.00 on declarative knowledge (DK), from 1.75 to 5.00 on procedural knowledge (PK) and from 2.80 to 5.00 on conditional knowledge (CK).

Since the teachers' total score (3.66) on MAI is greater than 2.50(table 2), it showed that the teachers were at higher level of cognition of knowledge. But teachers' responses to the open ended part of the questionnaire challenged the results of MAI showing that the teachers' level of knowledge about knowledge of cognition was poor or absent for most of them.

Table 2. Average Scores of Teachers (n=13) on MAI Questionnaire

	Average scores of each teacher on knowledge of cognition													Av
TI	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
DK	3.38	4.38	4.38	3.63	2.75	4.13	4.25	4.38	5.00	3.63	4.63	4.63	2.88	**4.00**
PK	2.50	3.25	4.00	2.75	**1.75***	2.75	4.00	3.00	5.00	3.75	3.50	4.25	**2.00***	**3.27**
CK	3.20	3.40	3.40	4.40	2.40	3.00	4.20	3.6	5.00	3.40	4.60	4.80	2.80	**3.71**
											Overall average →			**3.66**

Note: **TI**- Teachers' ID
1.75*and **2.00*** indicated low level of procedural knowledge.

This result agreed with what the researcher of this study faced during data collection from teachers. All the teachers complained that they didn't know metacognition even by name at least. Another cause of the contradiction might be, not knowing the strategies, the teachers responded to the MAI only for the sake of getting high scores or it might be their negligence response to the MAI part.

The Level of Practices of Metacognitive Strategies by Secondary School Teachers

In this section, students' questionnaire, principals' questionnaire and classroom observation checklist were analyzed to answer research question 2.

The analysis of students' responses to the 1st part of the questionnaire showed that most of the secondary school physics teachers (in Bako and Tibe SS) didn't use metacognitive strategies in their classrooms in physics teaching. The percentage analysis also indicated that the opinions of grades 9 and 10 students about the level of teachers metacognitive teaching was similar that in both cases that the levels of metacognitive teaching were very low. Furthermore, more principals observed that physics teachers in their schools never or seldom used mastery questions, scaffolding and think aloud strategies in their classrooms. In all cases, the majority of the principals reported that grades 9 and 10 physics teachers in their schools never or seldom used metacognitive strategies in physics teaching. Taking the sum of the averages for each item group the results were summarized in the table below as follow.

Table 3. Students' Responses to Level of Metacognitive Teaching (LMT)

Respondent group	Scale	Items group			
		1	2	3	4
Grade 9	Never/ seldom	40%	62%	42%	39%

	Often/ always	31%	19.4%	32%	35%
Grade 10	Never/ seldom	50%	71%	52%	50%
	Often/ always	27%	17.3%	27%	25%

For items group: 1. Verbalization, 2. Small group work, 3. Prompting questions, 4. Scaffolding and graphic organizers.

From these results, it might be said that most of the secondary school physics teachers (in Bako and Tibe SS) didn't use metacognitive strategies in their classrooms in physics teaching. Furthermore, the responses given by grades 9 and 10 regarding the level of practices of metacognitive teaching in physics by physics teachers were tested using the non-parametric Mann-Whitney U test for significance difference for each group of the items and the results were presented in the following table. Hence, there were no significant differences between responses of grades 9 and 10 students regarding LMT. This might indicate that teachers' level of metacognitive implementation was low whether the responses were given by grade 9 or grade 10 students.

Table 4. Mann-Whitney U Test between Grades 9 and 10 Students for 'Never/Seldom' Response.

Item group	1	2	3	4
Asymp.Sig. (2-tailed)	0.317	0.317	0.317	0.317

The data collected through observation checklist also conveyed that the levels of particular metacognitive strategies that physics teachers implemented in physics teaching were low.

Challenges of Implementing Metacognitve Strategies in Physics Teaching

The major challenges of metacognitive teaching identified by this study (from the responses of students and principals) were summarized as follows.

1. The strategies take large amount of time.
2. Large class size.
3. Students are psychologically not ready for those strategies.
4. Students consider the strategies as waste of time.
5. Students don't want such challenging strategies.
6. Students have no such learning experiences before.
7. The nature of the subject didn't allow the teacher to use those strategies.
8. The teacher wants to teach the content without challenging or analyzing.
9. The teacher didn't believe that those strategies help students' learning.

10. The teacher didn't know how to integrate those strategies in his/her classroom teaching.
11. The teacher possessed no skills to verbalize to students what he/she is thinking and how he/she processed the information.
12. The teacher didn't have enough knowledge regarding the strategies.

Based upon the number of respondents (students: grades 9 and 10, principals), their responses were counted, added and the means were calculated and given as in the following table.

Table 5. Responses of Students and Principals to (Challenges of Metacognitive Teaching) CMT

Items	Sd/d			Sa/a		
	G-9	G-10	Pr	G-9	G-10	Pr
1	43.6	47	0	42.7	52	75
2	55.8	52	12.5	37.5	44	87.5
3	50.7	57	25	29.5	35	50
4	53.9	55	12.5	28.6	45	37.5
5	51.6	64	25	30.9	31	62.5
6	41.7	48	12.5	42.2	57	75
7	58.6	70	75	28.1	22	0
8	50.7	33	37.5	41.3	75	62.5
9	55.8	52	37.5	27.7	42	37.5
10	51.6	43	12.5	28.6	54	50
11	43.1	37	37.5	40.8	65	25
12	52.1	49	25	37.1	29	12.5

sd/d= strongly disagree or disagree, sa/a= strongly agree or agree

G-9 = grade 9, G -10 = grade 10, Pr = principals

Lastly, responses from three of the respondents (grade 9, grade 10 and principals) were tested using one way ANOVA for any significant differences in their responses.

Table 6. Results of ANOVA Test Regarding CMT

	Sum of squares	df	Mean square	F	Sig.
Between groups	2.555	2	1.277	4.277	0.015
Within groups	105.123	352	0.299		
Total	107.677	354			

There was significant difference in responses of the three respondents at $p = 0.05$ level because of [$F(2,352) = 4.277$, $p = 0.015$]. There is a large difference in sample sizes between students and principals of this study. The post hoc test preferred for such cases is Hochberg's post hoc comparison. For this reason Hochberg's post hoc test was used for this analysis. This test at $\alpha = 0.05$ indicated that the mean responses of grade 9 students ($M = 2.7171$, $SD = 0.52825$) didn't significantly differ from the responses of grade 10 students ($M = 2.7072$, $SD = 0.58010$) while that of the principals ($M=3.2813$, $SD = 0.41533$) was slightly significant from that of students.

Although this test (Table 7) indicated that significant difference existed between the responses of the respondents, it didn't tell where the difference existed. Hence, the contrast test (Table 8) was carried out to indicate where the difference in responses existed.

Table 7. Descriptives of ANOVA Test

					95% confidence interval for mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Grade 9	213	2.7171	0.52825	0.0362	2.6458	2.7885	1.08	2.83
Grade 10	134	2.7072	0.5801	0.05011	2.6036	2.8019	1.25	4.42
Principals	8	3.2813	0.41533	0.14684	2.934	3.6285	2.5	3.92
Total		2.7244	0.55152	0.02927	2.6668	2.782	1.08	4.42

Table 8. Contrast Coefficients

Contrast	Group		
	Grade 9	Grade 10	Principals
1	1	0	-1
2	0	-1	1
3	1	-1	0

Contrasts 1 and 2 respectively compared responses of grades 9 and 10 students with that of the principals while the last contrast compared responses of grades 9 and 10 students to each other. Contrast 3 compared responses of grades 9 and 10 students. This showed that the responses were insignificant (p = 0.811) while that of the principals was significant from both groups of students as indicated (p = 0.004) by contrasts 1 and 2. Again it was noted that whether equal variances were assumed or not, there was no significant difference between responses of grades 9 and 10 students. The difference in responses of students and principals might be due to the difference in their levels of metacognition (perception about metacognition). It appeared that principals were at a higher level of metacognition than students of grades 9 and 10 in responding to challenges of metacognitive teaching at secondary schools. Hence, the difference in the level of metacognition led to different responses regarding CMT.

Teachers were also interviewed regarding CMT. The researcher carefully examined each interview to identify the described factors (challenges) that influenced metacognitive teaching as in table 9. It was noted that these responses were similar to the responses given by school principals above.

Table 9. Summary of Teachers' Responses to the Interview Responses Regarding CMT Teachers' ID

	The interview items and summarized responses				
	1	2		3	4
	What factors are limiting students' success in the subject physics?	What type strategies do you use most often in teaching physics?	Why do you use those strategies?	What factors are limiting you in helping your students develop metacognitive knowledge?	What factors are limiting your metacognitive teaching?
1	Students' low attitude towards physics	Working through examples	It is powerful for understanding	I don't know much about metacognitive strategies	I don't know much about the strategies, further ,the strategies need large amount of time and lastly the large class size didn't allow me that
2	Large class size, lack of laboratory materials, shortage of effective teachers	Lecture method but not metacognitive strategies	Large class size	The strategies need more tme and experience	large class size, students' lack of interest and lack of role models in using the strategies
3	Shortage of reference materials, unsuitable library, and students' low attitude towards	Lecture method	Large class size	Due to large class size I couldn't identify strong and weak side of students, students' poor background and lack of awareness	Students' low participations and lack of physics lab equipments

	physics	Demonstration method	For motivation		
4	Students are bored with its calculations formulas	Note giving followed by explanation Group discussion	Students listen to the explanations after taking notes Enables learners to learn from each other	Large class size, students' low attitude and lack of interest in knowing physics	Students lack of awareness on the strategies, large class size and insufficient time duration for one period
5	Poor teaching methodology and students' wrong beliefs about physics	Teacher centered	Large class size	Large class	Lack of knowledge of metacognition, large class size and shortage of time
6	Students think that physics is very difficult and they don't try	Through worked examples and questioning	Help learners to do more	Large class	The strategies take large amount of time
7	Large class size and teachers' poor skills in teaching the subject in standard language	Group work and problem based learning	Physics is the subject of practice and observation	Students' poor background, lack of interest in knowing physics and language problem	Absence of motivation and psychological reinforcement from school administration
8	Shortage of reference materials and teachers carelessness	Student centered	It makes students active participants	Large class	Large class size and students' carelessness
9	Students' lack of interest and language problems	Lecture method and group discussion	To achieve educational goals	Students lack of interest, poor discipline and weak parental follow up	Students' poor background, low attitude and large class size
10	Students' lack of psychological readiness to learn physics	_____	_______	Large class	Students' lack of interest
11	Students think that physics is very difficult and they don't try	Teacher centered	Shortage of time	I am not well trained in such strategies	Large class size and shortage of time
12	Large class size, students' lack of interest, shortage of reference materials and laboratory equipments	Teacher centered	To maintain logical order of the course	I don't know much about metacognitive strategies	Lack of model teachers who use the strategies
13	Students' low attitude and beliefs about physics	Lecture method	To cover the portion	Student's lack of interest and poor background	Large class size and shortage of time

Summary and Conclusion

Summary

The purpose of this research was to study about teachers' level of metacognitive knowledge, practices of metacognitive teaching and challenges of implementing metacognitive strategies in classrooms. This thesis considered three populations: students (grades 9 and 10), physics teachers and principals of Bako and Tibe secondary schools in the academic year of 2010/2011. PPS sampling method was used to consider 213 samples from grade 9 and 134 samples from grade 10 students which were selected by systematic sampling. Including all principals and physics teachers from both schools, the total sample size was 368 (347 students, 8 principals and 13 teachers). Questionnaire, classroom observation checklist and interview were used as instruments of data collection. Teachers' questionnaire was analyzed using percentage frequency on MAI regarding knowledge of cognition. The MAI analysis result showed that about 94.87% of teachers had declarative, procedural and conditional knowledge while the open ended result contradicted this showing that the teachers' level of knowledge about knowledge of metacognition was poor or absent for most of them. The percentage analyses of the checklist and questionnaire from teachers and principals on LMT conveyed that the levels of particular MS that physics teachers implemented in physics teaching were low. On this regard, responses of students were analyzed for significant differences using Mann-Whitney U test. The result showed no significant differences between grades 9 and 10 responses. Students' and principals' responses regarding CMT were analyzed using ANOVA test. The contrast test showed that there was no significant difference at $p = 0.05$ ($p = 0.811$) between grades 9 and 10 students on CMT while that of the principals was significantly different at $p = 0.05$ from students' responses ($p = 0.004$). On percentage analysis, both students' and principals' responses indicated the LMT by physics teachers to be low. The results of interview and open ended questionnaire indicated: low level of teachers' knowledge of cognition, lack of skills and interest in identifying and applying the strategies, teachers' failures in identifying students' individual differences, improper use of time, language barriers, the case that the strategies take large amount of time, large class sizes and students' poor backgrounds on physics were appeared to be CMT in Bako and Tibe secondary schools.

Conclusion

This study was designed to answer three questions. Based on the findings discussed so far, the following answers were found.

MAI scores of teachers indicated that their 94.87% of them had higher level of declarative, procedural and conditional knowledge. On the contrary, their responses to the open ended part confirmed that about 69.2% of the teachers had no clear idea about what is meant by metacognition, 92.3% of them were unable to list and describe the components of metacognitive knowledge to the desired extent and only 7.7% of the teachers participating in the research had good level of knowledge about classroom applications of metacognitive strategies. Totally, the levels of teachers' knowledge of declarative, procedural and conditional knowledge were low or absent. Although the teachers knew intuitively the concepts behind metacogition they did not know the operational definitions and other concepts that are attached to it.

According to the results obtained from students' and principals' questionnaires, majorities of students and principals responded physics teachers in their schools never or seldom used strategies which were metacognitive in nature. The result from the actual classroom observation checklist also confirmed the same result. Hence, the level of metacognitive teaching by those teachers was very low (never or seldom).

Questionnaire responses of students and principals, and teachers' interview results indicated that the implementations of metacognitive strategies were affected because of the following reasons. The strategies need large amount of time, the large class size, students were psychologically not ready and considered the strategies as waste of time, and the teachers had no enough knowledge about the strategies and didn't believe that the strategies help students. Improper use of time, language barriers, teachers' failures in identifying students' individual differences were also included in their responses. As discussed under Table 12, principals were at a higher level of metacognition than students of grades 9 and 10 in responding to challenges of metacognitive teaching at secondary schools.

Recommendations

The need of analyzing teachers' knowledge of cognition who will educate future generations is very essential. Based upon this and the findings of the study, the researcher highlighted the following.

1. Since teachers' level of knowledge of cognition was found to be low, the future will be not promising for metacognitive strategies unless metacognitive trainings will explicitly be given for teachers.
2. Teachers participated in this study forwarded that their university study helped them very little in terms of knowledge and classroom implementations of metacognitive strategies. Hence, teachers need professional development opportunities on metacognitive strategies.
3. Teacher resource centers will be expected to be available at secondary schools in order to play key roles in disseminating information and distributing resources, which the teachers in schools may need in order to enrich their metacognitve knowledge to facilitate the change process.
4. As the large class size affects the implementation of metacognitive teaching, the number of students in the class should be to the standard at secondary schools.
5. Features of pedagogy that will make metacognitive strategies usable in secondary schools needs to be researched.
6. This study was the first step of trying to understand teachers' level of metacognitive knowledge in physics classroom in Ethiopia. Further research should extend to metacognitive control which focuses on how students and teachers regulate their own learning and teaching activities.

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