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A Study of Metacognitive Knowledge and Metacognitive Regulation among Biology Teachers at Secondary Level

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Abstract

Metacognition is a higher-order thinking construct involving the control of cognition for effective learning. Metacognition has an important role in education because it can make the learner more involved in the learning process. Therefore, it is important to develop metacognitive awareness in students as well as teachers. The current study aimed to measure metacognitive knowledge and metacognitive regulation of Biology teachers at the secondary level. The key objectives of the research were to examine secondary school biology teachers' perception of their metacognitive knowledge and metacognitive regulation by identifying memory monitoring activities and metacognitive processes. For examination of teacher's metacognitive awareness, Schraw and Dennison's (1994) inventory (MAIT) adapted by Rehman (2011) was used as it is according to the socioeconomic setup of Pakistan. The reason for using the inventory was that it proved to be highly reliable. The inventory consisted of 37 items belonging to six dimensions of Metacognition i.e., Procedural knowledge, conditional knowledge, declarative knowledge, planning, monitoring, and evaluation. . The results indicate that the teachers have a high level of metacognitive knowledge and a lower level of metacognitive regulation. This means that majority of the teachers are aware of their knowledge, but they are week at planning, monitoring, and evaluating aspects of their knowledge. The study revealed that teachers were weakest at the evaluation dimension of the metacognitive regulation.

Keywords: conditional knowledge, declarative knowledge, evaluation, metacognitive knowledge, metacognitive regulation, monitoring, planning Metacognition, procedural knowledge

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Introduction

Development in science and technology has made teaching generally and science teaching specifically more challenging. Therefore, a science teacher should think, learn and reflect on his / her cognition to achieve the objectives of science teaching. It is the main consideration for educators to increase efficiency in lifelong learning. In an information-based society lifelong learning is very important. Learners become aware of their cognition, that is, Metacognition. Metacognition can be defined as the knowledge and use of cognitive processes for learning purposes (Ormrod, 2006).

Metacognition comprises two domains i.e., metacognitive knowledge and metacognitive regulation. (Dunlosky & Metcalfe, 2009). Metacognitive knowledge refers to the knowledge skills and strategies required to perform a task whereas metacognitive regulation involves the control of knowledge to solve problems (Schraw, Crippen & Hartley, 2009). Metacognitive knowledge comprises three different, but closely linked dimensions of knowledge: Declarative, procedural, and Conditional knowledge (Harris et al., 2010).

Statement of the Problem

The national curriculum of Pakistan for the subject of Biology was developed in 2006 and focused on problem-solving and higher-order thinking skills of students. (GOP, 2006). Teachers need to consider, plan and regulate their instructions before, during, and after conducting instructions to enhance their efficacy with students and to cultivate skills of higher-order among students. To teach science successfully, Metacognition can be used by the teachers not only to regulate their teaching but also to meet the needs of the students. Moreover, teachers can help students learn science more effectively by developing Metacognition in their students so that they may control their learning (Hartman, 2001).

Objectives of the Study

The study was conducted to meet the subsequent objectives.

1. To measure secondary school biology teacher's metacognitive knowledge.
2. To measure the metacognitive regulation of secondary school biology teachers.

Research Questions

The following questions were addressed in the study:

1. Do biology teachers possess procedural knowledge?
2. Do biology teachers possess declarative knowledge?
3. Do biology teachers possess conditional knowledge?
4. What is the level of teacher's planning?
5. What is the level of teacher's management activities?
6. Do teachers regulate their Metacognition by evaluation activities?

Literature Review

Learning can be defined as the act of gaining new, or reinforcement and modification of knowledge on hands, skills, behaviors, values, or preferences and might involve the process of synthesizing diverse information. Animals, Humans, and some machines possess the learning ability. Progress over time follows learning curves. Learning is contextual rather than being necessary. Learning is not a spontaneous process rather it is constructed over our past knowledge and experiences learning is not just gathering knowledge based on facts and figures rather it is regarded as a process. Learning produces relatively permanent changes in the organism (Schacter, Gilbert & Wegner, 2011).

The use of the word cognition is as old as the 15th century when it was used in the meaning of "thinking and awareness". More than 23 centuries ago significant attention was given to the cognitive process, beginning with the work of Aristotle as he had a curiosity about the inner workings of the mind that influence the individual experience. Cognitive areas related to perception, remembrance, and mental imagery were the main focus of Aristotle's studies. His studies were based on empirical evidence which means that the scientific information was gathered through observation and experimentation (Matlin, 2009).

The term metacognition was initially coined in the writings in the 1970s. Due to the relatively new nature of the concept of metacognition, many models and definitions have been presented which has made it a vague and complicated concept to study. On the other hand, many related constructs like cognition, motivation, critical thinking, metamemory, etc. have made it more difficult to organize and translate the research of metacognition (Tanner, 2012; Tarricone, 2011). Akpunar (2011) expressed that the term metacognition is also expressed as metacognitive awareness or metacognitive knowledge. Tobias and Everson (2009a, b) considered metacognition as being the most dynamic and vigorously researched area of

existing developmental, cognitive, instructional, and educational psychology. According to Costa & Kallick (2009), in simple words, metacognition is referred to as "thinking about thinking" or our capacity to understand what we know and what we don't. Anderson (2012) reflected that metacognition enables an individual to reflect and evaluate his thinking positively and healthily. Individuals with metacognitive understanding can regulate their thinking process more effectively.

According to Flavell's definition, metacognition consists of two components, i.e. "Metacognitive knowledge and metacognitive experience or regulation". Flavell also used the term "cognitive monitoring" to show a link between self-regulated learning and metacognition (Griffith & Ruan, 2005). According to Burke (2007), metacognitive skills are also called "self-direction skills". According to most of the researchers now the metacognition includes two basic elements or components viz.

1. Knowledge of cognition and
2. Regulation of cognition (Schraw & Moshman, 2006; McCormick, 2003; Harris et al., 2010; Williams & Atkins, 2009).

According to Schraw (2000) Knowledge of cognition is the awareness of an individual about his cognition and cognition in general. Metacognitive knowledge comprises three different, but closely linked, dimensions of knowledge: declarative, procedural, and conditional knowledge (McCormick, 2003; Harris et al., 2010).

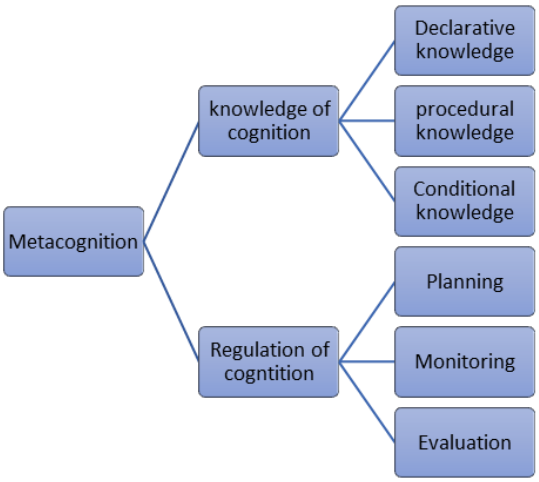

Figure 1: Source: Subcomponents of Metacognition. (Schraw, Crippen, and Hartley, 2006)

Declarative knowledge includes knowledge, strategies, and skills which are essential for completing a task under different circumstances (Pressley & Harris, 2006). The recent definition of declarative knowledge includes the knowledge and understanding of an individual's motivation and self-efficacy to accomplish a task (Harris, Graham, Brindle, & Sandmel, 2009).

For example, most learners are aware of the restrictions of their remembrance and then plan consequently (Schraw, Crippen, and Hartley, 2006). In brief, declarative knowledge consists of knowledge about the self, knowledge about the task, and the strategies required for the completion of a task.

Procedural knowledge means awareness of procedures, approaches, or activities to use declarative knowledge for the performance of goals (Harris et al, 2010; McCormick, 2003). Procedural knowledge can be taken as the knowledge needed for carrying out particular tasks or for the accomplishment of goals. It involves the Knowledge of procedures and learning strategies (Schraw, Krippen & Hartley, 2006). Conditional knowledge enables a person to know where, when, and how to use a specific strategy (Harris, Graham, Brindle & Sandmel, 2009). Conditional knowledge is needed by an individual to assess the needs of a learning environment and to select the suitable strategies for completion of the task (Schraw, Krippen & Hartley, 2006).

Conditional knowledge is described as the knowledge of the application of different procedures, skills, and cognitive actions or strategies according to the situation (McCormick, 2003; Schraw & Moshman 2000). Harris et al. (2010) concluded that Conditional knowledge is the knowledge of accurate use of declarative and procedural knowledge according to the needs and demands of the situation. Conditional knowledge is very important to use different strategies effectively.

On the other side, regulation of cognition refers to the control of cognition by planning, monitoring, and evaluating cognitive processes (Tarricone, 2011). Anderson (2012) suggested three elements of metacognitive regulation which are planning, monitoring, and evaluation. Planning is the process of identification and selection of suitable strategies and al resource allocation. It may include the setting of goals, activation of background knowledge, and time management. Monitoring or regulating is the act of attending and awareness about comprehension and task performance. It may include self-testing. Last but not least, evaluation is defined as the process of appraising and regulating the learning process of an individual.

Keeping in mind the above literature review, it can be concluded that most researchers have described metacognition as having two elements i.e.

1. Metacognitive knowledge: which is further classified as
a. Declarative knowledge
b. Procedural knowledge
c. Conditional knowledge
d. Metacognitive Regulation having three aspects further.
    i. Planning
    ii. Monitoring
    iii. Evaluation

Some researchers have also used the alternative words for elements of metacognition i.e.

i. Metacognitive awareness
ii. Metacognitive control

These alternative terms, however, have been used in the same context and meaning.

Since metacognition is not observable directly and is influenced by several other factors so it becomes challenging to assess Metacognition (Lai, 2011). Metacognition is a construct that is studied by researchers across the globe, although there is no agreement on its definition. Assessment data about metacognition is gathered from strategies like observation and self-report methods including surveys, inventories, interviews, and analysis of student writing and verbalizations (Tobias & Everson, 2009).

Researchers can use direct observation to find whether the learners are accomplishing the task however to determine whether the learners are using metacognitive strategies self-reports are required. Data collection can be done before, during, and after a learning activity. Think aloud and reflection-in-actions strategies can be used to ascertain student's thought processes. In this way, the learners keep on describing their thinking as they solve a problem (Tobias & Everson, 2009). One of the drawbacks of this approach for collecting data is that one can unintentionally distract from the content due to cognitive overload (Pate & Miller, 2011). Other strategies to assess monitoring techniques of the learners include the judgment of learning (JOL) and meta-comprehension analysis (Serra & Metcalfe, 2009). students are required to define the degree to which the contents have been learned by them or to anticipate that how well they perform a task or test activity. Students with better metacognitive monitoring skills are thought to make more accurate judgments of learning (Serra & Metcalfe, 2009). Quantitative

and qualitative data is gathered using many assessment techniques after the completion of a task by the learner. In reflection-on-action techniques, students describe their thinking process or use the inventory to rate their metacognitive skills (Tobias & Everson, 2009). Since it is an implicit process students may face difficulty in recalling the way they were thinking (Tobias & Everson, 2009).

The teacher performs a key role in the development of metacognitive awareness among students. Researches all over the world have proved that performance can considerably be improved if teachers are given even a short time metacognitive practice as pointed out by Coutinho (2006).

It can be summarized that a high level of metacognitive awareness enables teachers not only to educate future generations but to lay foundations for future benefits. Teachers with lack of metacognitive awareness have limited abilities to be effective teachers (Tuysuz et al., 2008). The pedagogical understanding of metacognition means that teachers should understand the requirement of teaching metacognition. In general terms, pedagogical understanding refers to the instructional techniques and teaching methods that are implemented in a given situation to achieve the goals of teaching. For the successful instructions of the metacognitive literacy knowledge of strategies, conditions for the implementation of strategies and student schemas should be addressed (Griffith & Ruan, 2005). Understanding of teachers about the necessities of the teaching-learning process strongly impacts their practice which in turn affects students learning (Zohar, 2006). Metacognition, in addition to a skill that has to be imparted, is a disposition of learning. (Harpaz, 2007).

It can be concluded from the above discussion that the learners must have their own eloquent learning experiences. Learners possibly cannot be taught everything they need to learn from well-structured programs and good teachers. To get good results from a study a learner needs to go beyond what is being provided by the program and the teachers. Learners also need to develop a metacognitive behavior to help them to regulate their learning.

Methodology

The research study was co relational in nature. The metacognitive awareness inventory of Schraw and Dennison (1994) was adopted because it is consistent.

Population

There are a total of 56 boy's schools and 51 girl's secondary schools, and each school has one biology teacher. The population of the research

study will comprise all the biology teachers and students of Tehsil Chakwal at the Secondary level.

Table 1
Population of the Study

	Males	Females
Schools	56	51
Biology Teachers	48	50

(*source:* School education department. Statistical report for the year2014-2016)

Sample of the Study

The random sampling method was adopted and a sample of 15 Biology teachers from male and 15 from female schools were selected for the collection of responses on MAIT

Development of Research Tool

A metacognitive awareness inventory of Schraw and Dennison (1994) was selected and adapted according to the needs of research. To test the conceptual understanding of students, the researcher used a self-administered test after checking its validity and reliability.

To collect data about the metacognitive awareness of teachers Metacognitive awareness inventory for teachers developed by Dennison and Schraw (1994) was used as it proved to be a valid and reliable instrument. An extensive literature review was done to select the most appropriate tool. The other reason for using the inventory was that Rehman et al. (2010) used this inventory for their study. Therefore, the researcher after discussion and permission from the above adopted the tool.

The tool was validated by Rehman et al. (2010) for socioeconomic set up in Pakistan. Hence it was considered a valid tool for the present study.

The inventory consists of two factors of metacognition i.e.

- Knowledge of Cognition includes awareness about one's knowledge and also the awareness of how to control and use that knowledge. This further included statements about
  - Declarative knowledge
  - Procedural knowledge

  - Conditional knowledge
- Regulation of cognition. Or metacognitive regulation refers to the control aspect of learning and includes:
  - Planning
  - Organizing and Management
  - Evaluation

Statements of the items were adapted from Dennison and Schraw inventory. Thirty-six statements were belonging to six components of metacognition. Procedural, conditional, declarative knowledge and planning, management, and evaluation. The inventory made was a 5-point Likert scale.

The inventory was interpreted into Urdu for local use. For this purpose, with the help of language, experts were taken and the statements were translated into Urdu. The interpreted version of the test was reviewed by several language experts and ambiguous statements were restated.

Analysis of Data

MAIT consisted of fourteen items belonging to metacognitive knowledge. Out of these fourteen items, ten statements belonged to declarative knowledge, six to procedural knowledge, and four belonged to conditional knowledge. Data obtained for different components of metacognitive knowledge is analyzed below. Percentages, Mean, Standard Deviation, and correlation were applied for the analysis of data by using SPSS software.

Results

Mean of responses=3.77

Table 2

Analysis of teachers' Declarative knowledge

Statement	Always	Usually	Sometimes	undecided	Not at all	Mean	St. dev.
N=30	*f(%)*	*f(%)*	*f(%)*	*f(%)*	*f(%)*		
I understand my intellectual strengths and weaknesses.	8(26.7)	8(26.7)	8(26.7)	5(16.7)	1(3.3)	3.57	1.165
I know what kind of information is most important to teach.	10(33.3)	15(50)	4(13.3)	1(3.3)	0(0)	4.13	.776
I am good at organizing information.	4(13.3)	14(46.7)	9(30)	2(6.7)	1(3.3)	3.60	.932
I know what the learners expect me to teach	1(3.3)	11(36.7)	7(23.3)	11(36.7)	0(0)	3.07	.944
I am good at remembering information.	7(23.3)	16(52.3)	6(20)	1(3.3)	0(0)	3.97	.765
I teach more when I am interested in the topic.	14(46.7)	13(43.3)	2(6.7)	1(3.3)	0(0)	4.33	.758

Table 2 shows the data analysis of subscale declarative knowledge. It contains 6 items. Most of the respondents showed usually high level of metacognition in this dimension (M=3.77). This table also explains the first objective of the research.

Table 3

Analysis of Teachers' Procedural Knowledge

Statement	Always	Usually	sometimes	Undecided	Not at all	Mean	St. dev.
N=30	*f(%)*	*f (%)*	*f(%)*	*f(%)*	*f(%)*		
I try to use strategies that have worked in the past.	09(30)	14(46.7)	5(16.7)	02(6.7)	0(0)	4.00	0.871
I have a specific purpose for each strategy I use.	14(46.7)	13(43.3)	02(6.7)	01(3.3)	0(0)	4.33	.758

I am aware of what strategies I use when I teach.	08(26.7)	10(33.3)	08(26.7)	02(6.7)	02(6.7)	3.67	1.155
I find myself using helpful teaching strategies automatically	02(6.7)	13(43.3)	04(13.3)	06(20)	05(16.7)	3.03	1.273

Mean of responses= 3.75

Table 3 describes conditional knowledge. There are four statements about Conditional knowledge. The majority of the respondents think that they are aware of different aspects of procedural knowledge (M=3.75). This table explains the first objective of the research.

Table 4
Analysis of Teachers Conditional Knowledge
Mean of responses=3.5

Statement N=30	Always *f(%)*	Usually *f (%)*	Sometimes *f(%)*	Undecided *f(%)*	Not at all *f(%)*	Mean	St. Dev.
I use different teaching strategies depending on the situation.	12(40)	12(40)	3(10)	2(6.7)	1(3.3)	4.07	1.048
I can motivate myself to teach when I need to	6(20)	13(43.3)	6(20)	3(10)	2(6.7)	3.60	1.133
I use my intellectual strengths to compensate for my weaknesses.	7(23.3)	13(43.3)	7(23.3)	2(6.7)	1(3.3)	3.77	1.006
I know when each strategy I use will be most effective.	3(10)	8(26.7)	9(30)	9(30)	1(3.3)	3.10	1.067

Table 4 shows the data analysis of subscale conditional knowledge. It contains 4 items. Most of the respondents showed usually medium level of metacognition in this dimension (M=3.5). This table also explains the first objective of the research.

Analysis of Metacognitive Regulation

There were a total of 23 items in MAIT belonging to metacognitive regulation. Five items were of planning dimension, eleven of

management strategies, and seven items belonging to evaluation. Data obtained for different components of metacognitive regulation is analyzed below.

Table 5

Analysis of Planning Aspect

Statement N=30	Always *f (%)*	Usually *f (%)*	Sometimes *f (%)*	undecided *f (%)*	Not at all *f (%)*	Mean	St. Deviation
I pace myself while teaching to have enough time.	12(40)	14(46.7)	4(13.3)	0(0)	0(0)	4.27	.691
I think about what I need to teach before I begin a task.	14(46.7)	9(30)	5(16.7)	2(6.7)	0(0)	4.17	.950
I set specific goals before I begin a task.	3(10)	14(46.7)	8(26.7)	5(16.7)	0(0)	3.50	.900
I read instructions carefully before I begin a task.	0(0)	4(13.3)	15(50)	2(6.7)	9(30)	2.47	1.074
I organize my time to best accomplish my teaching goals.	7(23.3)	17(56.7)	6(20)	0(0)	0(0)	4.03	.669

Mean of responses =3.58

Table 5 shows the data analysis of subscale planning. It contains 5 items. Most of the respondents showed usually medium to low level of metacognition in this dimension (M=3.58). This table also explains the first objective of the research.

Table 6

Analysis of Management strategies

Statement N=30	Always *f(%)*	Usually *f (%)*	Sometimes *f(%)*	Undecided *f(%)*	Not at all *f(%)*	Mean	St. Deviation
I slow down when I encounter important information	12(40)	13(43.3)	5(16.7)	0(0)	0(0)	4.23	.728
I consciously focus my attention on important information.	11(36.7)	12(40)	7(23.3)	0(0)	0(0)	4.13	.776
I use examples to make information more meaningful.	10(33.3)	15(50)	5(16.7)	0(0)	0(0)	4.17	.699
I draw pictures	10(33.3)	10(33.3)	7(23.3)	2(6.7)	1(3.3)	3.87	1.074

or diagrams while teaching.							
I try to translate new information into my own words.	9(30)	15(50)	4(13.3)	1(3.3)	1(3.3)	4.00	.947
I try to break the lesson down into smaller steps.	10(33.3)	16(53.3)	3(10)	0(0)	1(3.3)	4.17	.747
I think about several alternatives to a problem before I answer.	7(23.3)	12(40)	8(26.7)	1(3.3)	2(6.7)	3.70	1.088
I find myself pausing regularly while teaching	0(0)	3(10)	13(43.3)	3(10)	11(36.7)	2.27	1.081
When there is confusion, I stop and reteach.	6(20)	14(46.7)	9(30)	0(0)	1(3.3)	3.80	.887
I ask colleagues for help when I encounter some problem while teaching.	1(3.3)	9(30)	14(46.7)	0(0)	6(20)	2.97	1.129
I use the organizational structure of the text while teaching.	1(3.3)	7(23.3)	12(40)	10(33.3)	0(0)	2.97	.850

Mean of responses=3.5

Table 6 shows the data analysis of subscale management strategies. It contains 11 items. Most of the respondents showed usually moderate level of metacognition (M=3.5) in this dimension. This table also explains the first objective of the research.

Table 7
Analysis of Evaluation Dimension

Statement N=30	Always *f(%)*	Usually *f (%)*	Sometimes *f(%)*	undecided *f(%)*	Not at all *f(%)*	Mean	St. Deviation
I ask myself periodically if I am meeting my instructional goals	0(0)	1(3.3)	23(76.7)	6(20)	0(0)	2.63	.850
I find myself analyzing the usefulness of strategies while teaching.	6(20)	13(43.3)	9(30)	2(6.7)	0(0)	3.77	.858

I ask myself if I have considered all options after I solve a problem	0(0)	11(36.7)	10(33.3)	7(23.3)	2(6.7)	3.00	.947
. I ask myself if there was an easier way to do it.	0(0)	2(6.7)	16(53.3)	11(36.7)	1(3.3)	2.63	.699
I ask myself how well I accomplish my teaching goals once I am finished.	0(0)	13(43.3)	13(43.3)	3(10)	1(3.3)	3.27	.785
I know how well students have learned once I finished teaching.	11(36.7)	15(50)	3(10)	1(3.3)	0(0)	4.20	.761
I summarize what I have taught.	14(46.7)	12(40)	4(13.3)	0(0)	0(0)	4.33	.711

Mean of responses=3.4

Table 7 shows the data analysis of subscale Evaluation. It contains 7items. Most of the respondents showed a comparatively lower level of metacognition (M=3.4) in this dimension. This table also explains the first objective of the research.

Table 8

General Comparison of different components of Metacognition

Variables	Minimum	Maximum	Mean	Std. Deviation
Knowledge	9.83	12.50	11.1694	.68874
Regulation	9.56	12.54	10.7520	.64491

N=30

Table 8 shows the overall comparison of two dimensions of metacognition i.e. knowledge and regulation. The results indicate clearly that the respondents have good knowledge of their metacognition but lack regulation of their metacognition.

Table 9

Mean and Standard Deviation Values of Different Categories of MAIT

S. No	Parts	N	Mean	Std. Deviation
1	Declarative Knowledge.	30	3.7583	.37293
2	Procedural knowledge	30	3.7778	.43481
3	Conditional Knowledge	30	3.6333	.49451
4	Planning	30	3.5867	.36647
5	Measurement Strategies	30	3.5606	.26897

6	Evaluation	30	3.4048	.35409
7	Total metacognitive awareness	30	3.6423	.14225

Table 9 indicates the category-wise comparison of different aspects of metacognition. The data shows a comparatively higher mean score (3.8) of procedural and declarative knowledge while the mean of evaluation is the lowest (3.4).

Discussion

The contemporary study has explored the perception of teachers about their metacognition and its relationship to the teaching-learning process. Quantitative data was obtained through MAIT and a performance test. However, this is worth noting that most of the respondents tried to give positive responses to the questions of MAIT to present a better picture of their understanding which is quite natural.

Similarly, the results indicated that the metacognitive knowledge of the teacher is better than the metacognitive regulation. This is also not very surprising and is an indicator of the weakness of our education system, where the focus is rote learning. That is why the teachers possess knowledge but are unable to regulate their knowledge by activities like planning, monitoring, and evaluation. This finding is also supported by that of Schraw (2009) that learners differ with regards to the use of metacognitive regulation skills and not concerning metacognitive knowledge skills. Most of the learners possess metacognitive knowledge but lack regulation. Teng (2020) also noticed that university students with better meta-cognitive regulation skills show better than others which proves that metacognitive regulation skills play a vital role in improving the writing skills of university students. However, in general, metacognitive regulation is lacking. Teachers with lack of metacognitive awareness have limited abilities to be operative teachers (Tuysuz et al., 2008). Teachers' understanding of the meanings and purpose of teaching metacognition may influence their instructions. Rehman et al. (2010) found a positive correlation between metacognitive awareness and student performance in chemistry. Ali et al. (2020) observed that metacognitively aware teachers performed better in reading tests.

Conclusion

The results indicate that the teachers have a high level of metacognitive knowledge and a lower level of metacognitive regulation. This means that majority of the teachers are aware of their knowledge. It can therefore be concluded that the teachers are aware of their self-efficacy, nature of task, procedures, and strategies appropriate for achieving their goals.

Biology teachers lack awareness in all subcategories of the regulation dimension of metacognition. Teachers are weak at planning, monitoring, and evaluating their knowledge. The results of the study have also highlighted that the "Evaluation" dimension of metacognitive regulation is weakest. Teachers lack awareness about setting goals and time management. They also lack awareness about some aspects of management strategies.

Monitoring, self-assessment, and evaluation are the weakest areas as appraising their performance, revisiting and revising their goals, teaching methods and strategies are not part of the regular practices of Biology teachers.

Recommendation

1. It is recommended that some measures may be taken to improve teacher's awareness about monitoring and evaluation as tools to achieve educational goals effectively since they are the weakest areas of metacognition revealed in the current research.
2. Teacher training institutions should focus on the development of metacognitive regulation skills while designing curriculum as teachers are week at regulation of their knowledge.
3. The responses given by the teachers on MAIT cannot be judged as true or false so there is a need to use some other method for collecting data like observation method etc.
4. The research conducted here focused on a single subject and small area of population, it is suggested that future research be carried out in a larger area and many subjects including arts and science categories to see the reliability of the results.

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