Original Research Article

Relationship between Metacognitive Awareness and Reflective Learning of Medical Students at the Faculty of Medicine, Suez Canal University

Running title: Relation between Metacognition and Reflection

Abstract:

Background: Metacognition is a higher-order cognitive skill by which the learner can understand and control his thinking. Reflection is a very important skill that the learner can use to learn from his experience and make changes in his future performance.

Aim: to help medical students to be independent learners who can control their learning and improve their professional performance through fostering metacognition and reflective learning.

Subjects & Methods: This is a cross-sectional descriptive study; the study population included the undergraduate medical students in all study years at the Faculty of Medicine, Suez Canal University. The sample was 264 randomly selected students by using a cluster sampling technique. The instruments that were used for data collection were the Metacognitive Awareness Inventory (MAI) to measure students' metacognitive awareness levels, Reflection-in-Learning Scale (RLS) to measure the students' reflective learning levels.

Results: The descriptive statistics of both MAI and RLS total scores of students in the six study years revealed that students have mean total MAI total scores= 178 ± 26 and have mean total RLS total scores= 60 ± 13.

The Spearman's correlation between the metacognitive awareness and the reflective learning skills of medical students revealed that there was a statistically significant high positive correlation between the metacognitive awareness and the reflection in the learning of FOM-SCU students ($p= 0.699$, p-value<0.0001)

Conclusion: It is concluded from this study that the students at the Faculty of Medicine, Suez Canal University have fair to good metacognitive awareness and partial to ample reflective abilities. There is a significantly high positive relationship between metacognitive awareness and the reflective learning skills of medical students.

Keywords: Metacognition. Reflection & Self-regulated Learning.

Introduction:

Metacognition refers to awareness and control of an individual's thoughts and performance in the learning tasks, simply it can be defined as "thinking about thinking" [(1)]. It is considered to be a higher-order intellectual process that the learner use in the process of learning such as planning for the learning process, using certain skills and strategies for problem-solving, self-assessing his/her performance, and estimating the extent of learning [(2)].

Contemporary education has shifted from a focus on the transmission of knowledge to the construction of knowledge, aiming at self-regulated and lifelong learning. Central to the idea of self-regulated learning is the concept of metacognition [(3)].

Metacognition includes metacognitive knowledge and metacognitive control or

regulation [4]. Metacognitive knowledge refers to the learner's information about his cognition such as the student's knowledge of skills and methods that work best about his own, and how and when to utilize such skills and methods in a right way [5]. Metacognitive regulation refers to the intellectual activities that regulate one's thinking and learning process [6].

Knowledge of cognition consists of declarative knowledge, procedural knowledge, and conditional knowledge [7].

Regulation of cognition refers to the actions used to regulate and control the learning process. Its strength varies according to the different circumstances of educational situations. It includes planning, monitoring and evaluation [8].

The good problem-solvers have highly developed metacognitive skills. These learners know how to detect points of weaknesses in their thinking, organize their thinking processes, and re-evaluate the effectiveness of their efforts [9]. Metacognition is closely related to learning processes and academic achievement because it includes awareness of an individual's thinking processes and the ability to control his/her cognitive system [10].

Reflection refers to the process of critically analyzing one's experience and knowledge to accomplish a great understanding of the self as well as the learning task to make changes in future actions according to this understanding [11]. The process of reflection and reflective practise are powerful for developing deep and lifelong learning, and for accomplishing higher levels of professional training in a medical career [12].

The student's ability to reflect on his/her learning and to learn from experience is a fundamental skill needed for learning and making decisions in future actions. Therefore, developing learners' reflective thinking has been emphasized as a fundamental goal for deep learning in higher education. Learners not only reflect as a part of their subject-based activities but also reflect on their learning and intellectual skills development [13].

Reflection in medical education has been described as the critical thinking activity of the students that occurs consciously during achieving the educational task that aims to decrease the risk of non-conscious activities or practice which can lead to improper patient care and safety. It is a useful progressing skill that the student can use when he/she is faced with situations requiring flexible attitude [14].

Reflective learning is an important component of intellectual integrity and professional practice. For health professionals, reflection is considered a key skill because it is thought to facilitate learning from experience, self-assessment and self-monitoring, and the maintenance of competence over decades in practice [15].

The emergence of reflective practise is part of a change that recognizes the need for students to act and to think professionally. Activities to enhance reflection are now being incorporated into undergraduate, postgraduate and continuing medical education, and across different health professions [16].

Reflection has many potential benefits: It has been linked to knowledge integration, reducing the educational disadvantage of low-achieving students, and producing high conceptual gains among students [17].

Planning and self-monitoring allow students to identify what they knew and what they did not know, thereby supporting students' representation and construction of scientific concepts [18].

The consequences of integrating reflective practice into one's educational practice can include enhancement of patient care, the bridging of the gap of theory-practice and the stimulation of critical thinking to foster changes in practice [19].

Reflect to learn effectively from one's experience is critical in developing and maintaining competence across a practice lifetime. Most models of reflection include critical reflection on experience and practice that would enable identification of learning needs [16].

Reflection improves learning and performance in essential learning competencies. Specifically, reflective learning can improve professionalism and clinical reasoning, and reflective practice can contribute to continuous practice improvement and better management of complex health systems and patients [20].

This study aims to measure the metacognitive awareness and the reflective learning of medical students at the Faculty of Medicine, Suez Canal University and assess the relation between them hoping to improve and foster the student-centred learning of the medical students.

Subjects and Methods:

Type of the study:

This was a correlational descriptive study in which both metacognitive awareness and reflective learning skills of medical students were measured.

Site of the Study:

The study was conducted at the Faculty of Medicine, Suez Canal University, in Ismailia governorate during the academic year (2017-2018).

Target Population:

The study population included: the undergraduate students in all study years at the Faculty of Medicine, Suez Canal University

Sample size and type of sample:

Two hundred and sixty-four randomly selected participants from all study years (191 females & 73 males) were invited to participate in this study by using a cluster sampling technique.

The participants in this study were randomly selected using a cluster sampling technique. An equal proportion of students around 27.4 of each study year to be involved in the study. Forty-six students from 1st year, forty-seven students from 2nd year, fifty-five students from 3rd year, forty students from 4th year, thirty-seven students from 5th year and thirty-nine students from 6th year.

Data collection and Instrumentations:

1. **Metacognitive Awareness Inventory (MAI):**
   MAI was used to assess the awareness of students about their metacognitive abilities. It is a 52-item self-report questionnaire with a 5-points rating scale (1=never to 5= always) following each item. The results of the exploratory factor analysis have demonstrated that the items are loaded on eight factors; being: declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, information management strategies,

debugging strategies, and evaluation [21].

2. **Reflection-in-Learning Scale (RLS):**
   RLS was used to assess the students' reflective learning. The 14 - item version of the RLS appraised the reflective learning process. Each item of this self-report questionnaire features a 7-point response scale anchored at the extremes by 1=never and 7=always. The tool includes a self-assessment question on personal efficacy for self-determination for the ability to reflect on learning [22].

MAI and RLS were introduced to each participant to assess his/her awareness about his/her thinking and reflective abilities.

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS version 20). Data was presented in tabular and graphic forms. Data were tested for normality, appropriate tests were conducted consequently according to data normality, data were presented either by tables or graphs

Results:

1-The demographic data of the study population

Figure (1) showing the distribution of the students from all study years. The majority of the respondents were females 191 (72.3%) while the male respondents were 73 (27.7%). The participants from 1st, 2nd, 3rd, 4th, 5th and 6th years share a percentage of 17.4%, 17.8%, 20.8%, 15.2%, 14% and 14.8% respectively from the total participants.

2-Descriptive statistics of the study questionnaires (MAI and RLS)

Table (1) shows means and standard deviations of both MAI and RLS total scores of students in the six study years which revealed that students have mean total MAI total scores= 178 ± 26 and have mean total RLS total scores= 60 ± 13

While the descriptive statistics of the eight factors of the MAI questionnaire were shown in (table2) revealed that the students have the conditional knowledge higher than the other metacognitive knowledge components and have the skills of information management and debugging strategies higher than the other metacognitive regulation skills.

The descriptive statistics of the 14 items of the RLS questionnaire were shown in (table3) which revealed that the medical students have the skills of talking with colleagues, mentally processing the information, awareness of learning task and ponder for learning higher than the other reflective learning skills.

3- Correlations between variables using the Spearman correlation coefficient.

The Spearman's correlation between the two questionnaires revealed that there was a statistically significant high positive correlation between the metacognitive awareness and the reflection in learning of FOM-SCU students. The Spearman's correlation coefficient was **0.699** as shown in (table 4).

Table 5 showing the Spearman's correlations coefficient between the RLS total scores and the eight components of metacognition revealed that there was a statistically significant moderate positive correlation between them of FOM-SCU students. The spearman's correlation

coefficient was higher between RLS total scores and conditional knowledge (p= 0.605, p-value<0.0001) than the other components of metacognition.

Discussion:

Students' perceptions regarding their metacognitive awareness and reflective learning:

According to Pantiwati [23] who divides the percentage of metacognitive awareness scores by <40.0% which means very poor; 40.0-54.9% means poor; 55.0-69.9% means fair; 70.0-80.0 means good, and>80.0 means very good. In our study, the medical students have a percentage of metacognitive awareness scores ranging from **58.5 % to 78.5 %** (M=178, SD=26, N=264) that means **fair to good** metacognitive awareness levels.

According to Khan et al [24] the final score of RLS was further divided into 4 sub-scales representing the self-assessment question, participants scoring 14-34 were designated as limited reflective level, subjects having 35-55 score presented partial reflective level, as well as students, demonstrated 56-76 score have ample level of reflection and students have maximum level of reflection when they score 77-98. In our study, the medical students have a reflective learning total scores ranging from **47 to 73** that means **partial to ample** levels of reflection**.**

The relation between students' Metacognitive Awareness and reflection in learning:

In our study, the Spearman's correlation was tested between the students' MAI and RLS total scores. It revealed statistically significant high positive correlation between both (p=6.99, p-value <0.0001). This result may indicate that introducing more reflective activities to students to be involved in, will lead to enhance and develop their metacognitive awareness skills.

The Spearman's correlations were tested between the eight components of metacognition and the RLS. It revealed a significant and positive correlation to each other with the highest correlation between RLS and conditional knowledge (p=6.05, p-value <0.0001). This finding may be due to the Problem Based Learning and Community-Based Medical Education environment that enhance problem-solving and experiential learning skills that foster the students' capacities of when and why to apply different cognitive actions.

This positive correlation between metacognition and reflection was consistent with the study of Mair that performed on year 2 undergraduate psychology students who were asked to complete the MAI using a six-point Likert scale before and after six weeks of online structured, critical reflective practice. This study revealed that reflective practice leads to increased metacognitive awareness (MAI baseline (M=4.12, SD=0.47), MAI post-study (M=4.23, SD=0.48)) [12].

This finding was consistent with the study of Kuper that was conducted on new graduates nurses in the School of Nursing at the University of North Carolina, Wilmington in North Carolina, USA. This study differed from our study in using qualitative instruments for data collection as participants were assigned to self-reflect after a minimum of 5 to 6 weekly clinical experiences using Self-regulation Learning Prompts for Reflection on Clinical Experience and self-evaluate metacognition using Evaluation Guide for Self-regulation Learning Prompt Responses. This study revealed that the reflection exercise-trained

interns to become more metacognitive in their clinical reasoning in practice daily [25].

Self-assessment:

Strength of the study:

- Assessing the relationship between metacognitive awareness and reflective learning has been scantly explored in research worldwide.
- This is the first study evaluated the medical students' metacognition and reflective learning in Egypt.
- The used instruments (MAI and RLS) were valid tools and tested for reliability.

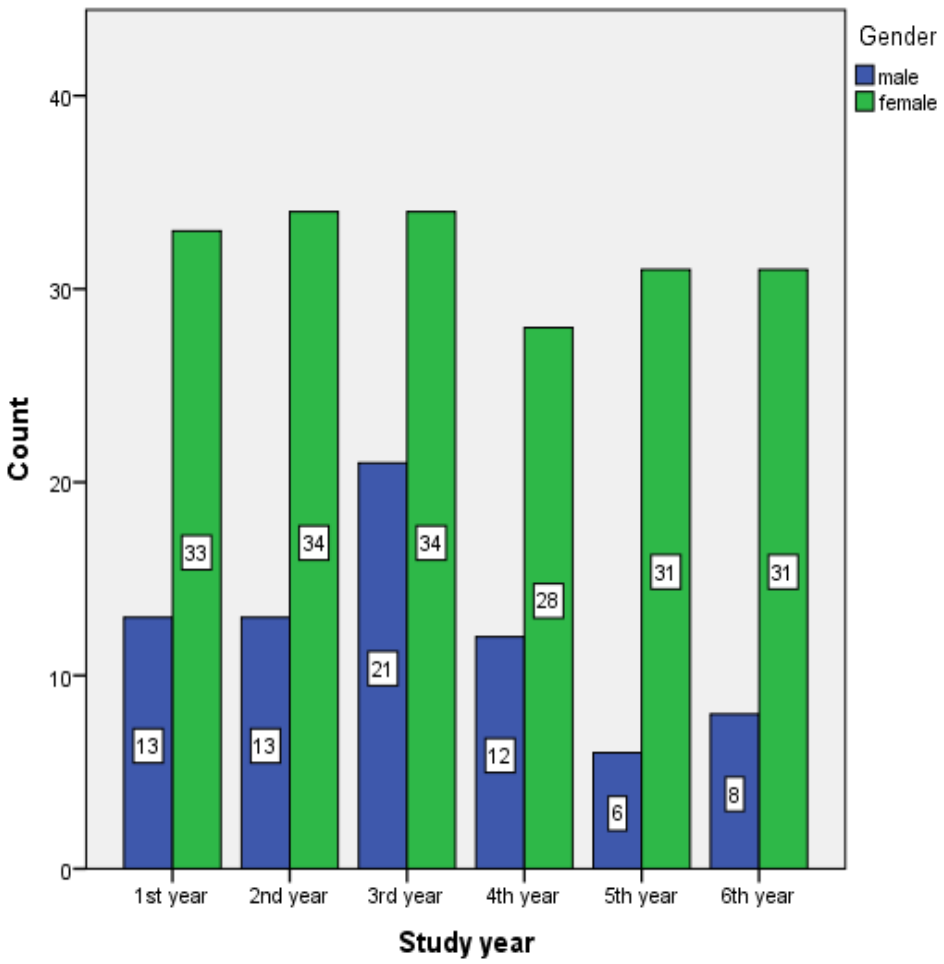
Limitations of the study:

- This research was conducted at only one school (FOM-SCU) which might limit the generalizability of the findings.
- Reliance is only on quantitative analysis. However, a combination of quantitative and qualitative analysis might permit a further investigation.

Conclusion:

It is concluded from this study that the students at the Faculty of Medicine, Suez Canal University have fair to good metacognitive awareness and partial to ample reflective abilities. There is a statistically significant high positive relationship between students' metacognitive awareness and reflective learning that may emphasize the assumption of applying more reflective thinking activities will enhance the students' metacognitive awareness that in turn will lead to higher achievement and professional performance.

List of figures:



List of tables:

Table 1: Means and standard deviation of both the Metacognitive Awareness Inventory and Reflection-in-Learning Scale total scores in each study year (n=264)							
Totals	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
MAI total score	183 ± 23	183 ± 22	162 ± 33	183 ± 21	178 ± 23	181 ± 21	178 ± 26
RLS total score	63 ± 13	61 ± 11	54 ± 14	60 ± 12	59 ± 14	62 ± 11	60 ± 13

Numbers represent mean ± standard deviation

Table 2: Means and standard deviations of the eight factors of the Metacognitive Awareness Inventory in each academic year (n=264)							
Factors	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Declarative Knowledge	3.45 ± 0.52	3.45 ± 0.61	3.03 ± 0.74	3.46 ± 0.47	3.33 ± 0.61	3.37 ± 0.47	3.34 ± 0.61
Procedural Knowledge	3.29 ± 0.64	3.44 ± 0.64	3.1 ± 1.3	3.48 ± 0.6	3.26 ± 0.58	3.35 ± 0.53	3.31 ± 0.8
Conditional Knowledge	3.61 ± 0.55	3.5 ± 0.55	3.2 ± 0.73	3.49 ± 0.5	3.44 ± 0.56	3.53 ± 0.52	3.45 ± 0.59
Planning	3 ± 1	3 ± 1	3 ± 1	3 ± 1	3 ± 1	3	3 ± 1
Information Management Strategies	4 ± 1	4	3 ± 1	4 ± 1	4	4 ± 1	4 ± 1
Comprehension Monitoring	3 ± 1	3 ± 1	3 ± 1	3	3 ± 1	3 ± 1	3 ± 1
Debugging Strategies	4 ± 1	4 ± 1	3 ± 1	4 ± 1	4	4 ± 1	4 ± 1
Evaluation	4 ± 1	4 ± 1	3 ± 1	4 ± 1	3	3 ± 1	3 ± 1

N.B. scales were rated out of 5

Numbers represent mean ± standard deviation

Table 3: Means and standard deviations of the Reflection-in-Learning Scale items in each academic year (n=264)							
Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
1. Carefully plan tasks.	3.96 ± 0.21	3.81 ± 0.21	3.85 ± 0.21	4.10 ± 0.47	3.92 ± 0.23	4.05 ± 0.19	3.88 ± 0.09
2. Talked with colleagues	4.80 ± 0.23	4.77 ± 0.17	4.02 ± 0.20	4.43 ± 0.21	4.38 ± 0.22	4.54 ± 0.22	4.48 ± 0.09
3. Review study	4.24 ± 0.23	4.00 ± 0.24	3.60 ± 0.21	4.20 ± 0.25	3.68 ± 0.30	3.92 ± 0.24	3.93 ± 0.10
4. Integration	4.11 ± 0.9	4.40 ± 0.19	3.62 ± 0.20	4.28 ± 0.19	3.92 ± 0.25	4.51 ± 0.20	4.12 ± 0.08
5. Process mentally	4.59 ± 0.22	4.34 ± 0.19	4.11 ± 0.19	4.45 ± 0.19	4.32 ± 0.21	4.82 ± 0.17	4.42 ± 0.08
6. Aware of learning task	5.13 ± 0.23	4.28 ± 0.18	4.04 ± 0.21	4.53 ± 0.21	4.54 ± 0.21	4.44 ± 0.19	4.47 ± 0.09
7. Develop interrelation	4.50 ± 0.22	4.43 ± 0.19	3.82 ± 0.18	4,45 ± 0.19	4.35 ± 0.19	4.79 ± 0.15	4.36 ± 0.08
8. Ponder for learning	5.04 ± 0.18	4.94 ± 0.20	4.25 ± 0.20	4.68 ± 0.18	4.35 ± 0.22	4.72 ± 0.17	4.66 ± 0.8
9. Change myself for study	4.13 ± 0.23	4.72 ± 0.18	4.04 ± 0.22	4.45 ± 0.13	4.43 ± 0.22	4.62 ± 0.18	4.38 ± 0.08
10. Reflection on study	4.67 ± 0.24	4.16 ± 0.21	3.76 ± 0.23	4.05 ± 0.20	4.49 ± 0.23	4.79 ± 0.16	4.33 ± 0.09
11. Make summary	4.63 ± 0.21	3.91 ± 0.24	4.05 ± 0.23	4 .33± 0.21	4.00 ± 0.25	4.62 ± 0.22	4.25 ± o.09
12. Use capacity to reflect	4.65 ± 0.22	4.49 ± 0.19	4.09 ± 0.24	4.35 ± 0.18	4.30 ± 0.22	4.51 ± 0.20	4.39 ± 0.09
13. Remove negativity	4.46 ± 0.26	4.55 ± 0.22	3.93 ± 0.22	3.98 ± 0.20	4.41 ± 0.27	4.49 ± 0.21	4.29 ± 0.09
14. Self-assess	3.78 ± 0.14	3.94 ± 0.18	3.16 ± 0.15	4.02 ± 0.16	3.70 ± 0.16	3.97 ± 0.17	3.73 ± 0.07

N.B. scales were rated out of 7

Numbers represent mean ± standard deviation

Table 4: Spearman's Correlation coefficient between the Metacognitive Awareness Inventory and Reflection-in-Learning Scale total scores		
	RLS score	
MAI score	P	p-value
	0.699	<0.0001

Table 5: Spearman's correlation coefficient between Reflection-in-Learning Scale total score and the eight factors of the Metacognitive Awareness Inventory		
	RLS total score	
	P	p-value
Declarative Knowledge	0.557	<0.0001
Procedural knowledge	0.446	<0.0001
Conditional knowledge	0.605	<0.0001
Planning	0.589	<0.0001
Information management strategies	0.577	<0.0001
Comprehension monitoring	0.584	<0.0001
Debugging strategies	0.463	<0.0001
Evaluation	0.569	<0.0001

References:

1. Flavell JH. Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. Am Psychol. 1979;34(10):906–911.

2. Schneider EF, Castleberry AN, Vuk J, Stowe CD. Pharmacy Students ' Ability to Think About Thinking, .Am J Pharm Educ 2014;78(8):148–155.

3. Cubukcu F. Learner autonomy, self regulation and metacognition. Int Electron J Elem Educ. 2009;2(1):53–64.

4. Veenman V J & Bernadette H. A. M. Van Hout-Wolters, Afflerbach P. Metacognition and learning : conceptual and methodological considerations, *Metacognition Learning*. 2006;1:3–14.

5. Mahdavi M. An Overview : Metacognition in Education. Int J Multidiscip Curr Res. 2014;(June):529–535.

6. Coutinho SA. The relationship between goals, metacognition, and academic success. Educate~. 2007;7(1):39–47.

7. Arslan S, Akin A. Metacognition: As a predictor of one's academic locus of control. Educational Sciences. 2014;14(1):33–39.

8. Çetin B. Metacognition and Self-regulated Learning in Predicting University Students' Academic Achievement in Turkey. J Educ Train Stud. 2017;5(4):132-138.

9. Tosun C, Senocak E. The effects of problem-based learning on metacognitive awareness and attitudes toward chemistry of prospective teachers with different academic backgrounds. Aust J Teach Educ. 2013;38(3):61–73.

10. Bayındır D, Dağal AB. The Investigation of the Relationship between the Level of Metacognitive Awareness, Self-directed Learning Readiness and Academic Achievement of Preschool Teacher Candidates. Univers J Educ Res. 2016;4(11):2533–2540.

11. Rogers RR. Reflection in Higher Education : A Concept Analysis, *Innovative Higher Educaton.*. 2001;26(1):37–57.

12. Mair C. Helping Students Succeed through Using Reflective Practice to Enhance Metacognition and Create Realistic Predictions. Psychol Teach Rev. 2012;18(2):42–46.

13. Sandars J. The use of reflection in medical education: AMEE Guide No. 44. Med Teach. 2009;31(8):685–695.

14. Chaffey LJ, Johanna E, Leeuw J De, Finnigan GA. Facilitating Students ' Reflective Practice in a Medical Course : Literature Review, *Education for Health*. 2017;25(3):189-203.

15. Moore DE, Green JS, Gallis HA. Achieving desired results and improved outcomes: integrating planning and assessment throughout

learning activities. J Contin Edu Heal Prof. 2003;161(137):1–51.

16. Mann K, Gordon J, MacLeod A. Reflection and reflective practice in health professions education: A systematic review. Adv Heal Sci Educ. 2009;14(4):595–621.

17. Reiser BJ. Scaffolding complex learning: The mechanisms of structuring and problematizing student work. J Learn Sci. 2004;13(3):273–304.

18. Wilson T, Perry M, Anderson CJ, Grosshandler D. Engaging young students in scientific investigations : prompting for meaningful reflection, *BRITISH JOURNAL OF NURSING*. . 2012;19–46.

19. Jorwekar GJ. Reflective practice as a method of learning in medical education : history and review of literature, International Journal of Research in Medical Sciences. 2017;5(4):1188–1192.

20. Aronson L. Twelve tips for teaching reflection at all levels of medical education, *Medical Teacher*. 2011;200–205.

21. Schraw G, Dennison RS. Assessing Metacognitive Awareness. Contemp Educ Psychol. 1994;19(4):460–475.

22. Sobral DT. An appraisal of medical students' reflection-in-learning. Med Educ. 2000;34(3):182–187.

23. Pantiwati Y. Self and Peer Assessments in Active Learning Model to Increase Metacognitive Awareness and Cognitive Abilities. Int J Instr. 2017;10(104):185–202.

24. Khan NF, Saeed M, Yasmin R, Butt AK, Khan AA. Age and Gender Based Differences in Self-Assessed Reflection- in-Learning Scale, *Journal of the Pakistan Dintal Association*. 2018;27(3):133–139.

25. Kuiper RA. Promoting Metacognition by Reflecting with Self Regulated Learning Prompts 1, *California Academic Press*. 2002;33:1–7.