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

Authors:

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Authors contribution:

The first author prepared the proposal, collected the data make the analysis and literature review, then prepared the first draft of manuscript, the second author reviewed and prepared the last version of the manuscript and share in the data analysis and discussion writing. the other two authors shared in preparing the proposal and revision of the whole work.

ABSTRACT:

Aim: to examine the relationship between reflective thinking and metacognitive awareness in order to help medical students to be independent learners who can control their own learning and improve their professional performance.

Study design: it is a cross sectional correlational study**.**

Place and duration of the study: this study was conducted at Faculty of Medicine- Suez Canal University at the august 2018.

Methodology: This is a cross-sectional correlational 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 cluster sampling technique. The instruments that were used for data collection were 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 a 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 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 significant high positive relationship between the metacognitive awareness and the reflective learning skills of medical students.
Keywords: *Metacognition, Reflection, Self-directed learning, Self-regulated Learning.*

1. Introduction:

Education is no longer seen as transmission of knowledge, especially learner nowadays are taking more responsibility regarding his or her own learning. Rather, the focus now is on knowledge construction, which in turn requires learner to be lifelong learners and self-regulated. Metacognition is considered the main idea of self-regulated learning [(1)].

In this regards, metacognition means learner should be aware of his thoughts and performance and can control both to achieve the learning task. in simple words, it can be defined as "thinking about thinking" [(2)]. 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 [(3)].

Metacognition includes metacognitive knowledge and metacognitive control or regulation [(4)]. Metacognitive knowledge means knowing what is the individual's own cognition, such as information about the suitable skills and methods work best for his learning and how and when to use these skills appropriately [(5)]**.** This type of knowledge includes three categories which are declarative, procedural, and conditional knowledge [(6)].

In the other hand metacognitive regulation means intellectual activities that regulate thinking and learning [(7)]. it refers to the actions used to regulate and control the learning process, these actions begins with planning and setting goals, and then monitoring and finally evaluation. Strengths of these skills depends on the quality of educational experience [(8).]

The good problem-solvers have highly developed metacognitive skills. These learners know how to detect points of weaknesses in their own thinking, organize their thinking processes, and re-evaluate the effectiveness of their efforts [(9)]. Metacognition is related to academic achievement because learner knows how he think and he is able to control his learning[(10)].

As we can see metacognition is an important skill to improve leaner's achievement. We hypothesize in this study that reflective thinking correlate to metacognition, and enhancing the reflective practice will improve metacognition which in turn will affect students achievement positively. It is evident that reflection improve deep and lifelong learning and professional development [12]. Reflection on experience is an effective strategy to plan for actions in the future. Learner does not reflect on subject-based activities only, but he reflects on his thinking, higher intellectual skills, and his learning too [13].

We learn from reflecting on experience, not simply from the experience as it happened; when experience goes unnoticed, no learning occurs. reflection is very important in situations where professional behavior is required to improve patient care and secure his/her safety [14]. Reflection is now implemented across medical specialties and in all levels of learning; undergraduate, postgraduate and continuing medical education, it is a key skill in professional practice as it facilitates learning through self-assessment, monitoring and improvement, and it maintains competence[16,15]. reflection means the ability of learner to critically analyze the learning task in order to understand the nature of the task and one's own thinking and learning to make improvement in the future[11].

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].

Reflective practice has many benefits such as linking theory to practice, enhancement of critical thinking and analysis, improving patient care and finally it fosters changes in practice [19].

Through reflection, learner can identify his learning needs and maintain his competencies, specifically, essential ones such as clinical reasoning, professionalism and patient safety, it leads to continuous improvement of practice and health system management [20].

The aim of this study is 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-centered learning of the medical students.

2. Methodology:

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

2.2. 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).

2.3. Population and sample:

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

Two hundred and sixty-four randomly selected students from all college years were invited to participate in this study according to the following equation.

$$n = 2 + [(Z_{a/2} + Z_{b/2}(1 - r^2)^{1/2})/ r]^2$$

(Dawson and Trapp, 2004)

Where

n= sample size

Z α/2 = 1.96 (The critical value that divides the central 95% of the Z distribution from the 5% in the tail)

Zβ = 0.84 (The critical value that separates the lower 20% of the Z distribution from the upper 80%)

r = correlation

The participants in this study were randomly selected using a cluster sampling technique. 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.

2.4. Data collection and Instrumentations:

2.4.1. 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)]. The total score of the instrument is calculated through sum the mean of all items. According to Pantiwati [(22)] 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

2.4.2. **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 self-assessment question on personal efficacy for self-determination for the ability to reflect on learning [(23)]**.**

The total score of the instrument is calculated through sum the mean of all items. 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.

MAI and RLS were introduced to each participant to assess his/her awareness about his/her own 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 was tested for normality, appropriate tests were conducted consequently according to data normality, data was presented either by tables or graphs

2.5 Ethical approval; this study was approved by research and ethics committee at Faculty of Medicine – Suez Canal University

3. Results:

3.1. The demographic data of 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.

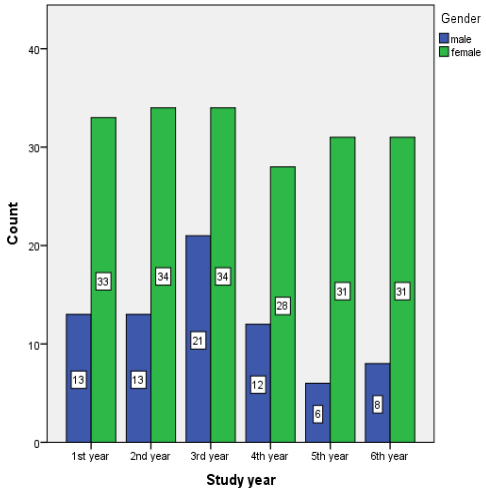

Figure (1): The students' response in each study year (n=264)

3.2. 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

Table 1: Means and standard deviation of both 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

Comment [TK1]: Why no decimals

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.

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

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.

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 ±	3.91 ±	4.05 ±	4 .33±	4.00 ±	4.62 ±	4.25 ± o.09

	0.21	0.24	0.23	0.21	0.25	0.22	
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

3.3. Correlations between variables using 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).

Comment [TK2]: Not sure why a Spearman was run. You created mean scores for each outcome so the new measure was a continuous variable. In both tables that follow it appears that you developed a mean score for the RLS score for each person and then created mean scores in the eight factors for each person. If so again in both cases you have continuous variables. Please comment

Table 4: Spearman's Correlation coefficient between Metacognitive Awareness Inventory and Reflection-in-Learning Scale total scores

	RLS score	
MAI score	P	p-value
	0.699	<0.0001

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.

Table 5: Spearman's correlation coefficient between Reflection-in-Learning Scale total score and the eight factors of 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

3.4. Multiple Regression Analysis

We performed multiple regression analysis to predict the value of metacognition awareness based on the four factors of the reflection in learning scale, which are planning, monitoring, reflection and self testing. These factors were extracted in a study which measures the validity and reliability of reflection in learning questionnaire by using confirmatory factor analysis. [25]

Table 6 shows that The R Square and Adjusted R Square values, which are .580 and .574, respectively, which means the\at the weighted combination of the predictor variables explained approximately 50% of the variance of reflection in learning.

Table 6: multiple regression analysis between Metacognitive Awareness Inventory total score and four factors of Reflection-in-Learning Scale

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.762[a]	.580	.574	16.848	1.600

a. Predictors: (Constant), Selftesing, Planning, Reflection, Monitoring

b. Dependent Variable: MAI total score

On examining the correlation between each factor of reflection in learning and the metacognitive awareness when the other factor are treated as covariates, the (Beta) coefficients, and their significance levels determined by t tests revealed that, all of factors, except planning, are statistically significant. By examining the beta weights, self testing followed by reflection followed by monitoring contribute largely to the prediction model.

Table 7: Correlation between metacognitive awareness inventory total score and each factor of reflection in learning scale.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	86.260	5.043		17.106	.000
	Planning	1.000	1.139	.045	.878	.381
	Monitoring	3.484	1.305	.160	2.670	.008
	Reflection	7.196	1.283	.305	5.609	.000
	Selftesing	9.682	1.410	.383	6.866	.000

a. Dependent Variable: MAI total score

4. Discussion:

Students' perceptions regarding their metacognitive awareness and reflective learning:

In this study we examined the relation between metacognition and reflection first we determined the metacognitive score and reflection separately 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) means **fair to good** metacognitive awareness levels. [(22)]

Moreover, students have a reflective learning total scores ranging from **47 to 73** that means **partial to ample** levels of reflection**.** [**(24)**]

After measuring metacognitive awareness and reflection among study population, we examine relation between students' Metacognitive Awareness (MAI) and reflection in learning (RLS). the Spearman's correlation revealed statistically significant high positive correlation between both (p=6.99, p-value <0.0001). This result may indicate that introducing more reflective activities will enhance and develop their metacognitive awareness skills.

The Spearman's correlations were tested between the eight components of metacognition and the RLS. It revealed 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 lead to increased metacognitive awareness (MAI baseline (M=4.12, SD=0.47), MAI post study (M=4.23, SD=0.48)) [(11)].

The multiple regression analysis shows that metacognitive awareness was primarily predicted by lower levels of self testing and reflection, and to a lesser extent by monitoring and planning. This finding was consistent with the study of Kuper that was conducted on newly 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 on a daily basis [(26)]. in addition a study was conducted by Tukey showed that when students practice reflection through writing short essays and discussing them in brainstorming session their response in the scale of metacognition enhanced. [(27)]

limitations and implication for further research:

This study explore the effects of reflective practices on metacognitive awareness and identifies exactly which reflective component has the great effect. Which opens the door for further research to plan for reflective activities in order to enhance students' metacognition. The used instruments (MAI and RLS) were valid tools and tested for reliability. However, this research was conducted at only one school (FOM-SCU) which might limit the generalizability of the findings, furthermore, reliance is only on quantitative analysis. However, a combination of quantitative and qualitative analysis might permit further investigation.

5. Conclusion:

It is concluded from this study that the students at 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.

Comment [TK3]: How can you say this?

Conflict of interest: all authors declare that there is no conflict of interest for this work

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