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Original Article

The Effect of Mind Mapping on Cognitive Achievement and Critical Thinking skills of Nursing Students

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Abstract

Background: An innovative thinking technique called mind mapping can help nursing students learn to retain the key ideas and establish a learning environment that promotes information processing. The research **aimed to** investigate the effect of mind mapping on cognitive achievement and critical thinking skills of nursing students. **Research design**: A Quazi- experimental research design was utilized. **Research setting**: This research was carried out at Al -Azhar Faculty of Nursing, in Nasr city, Cairo. **Research sample**: 156 third-year nursing students who signed up for the nursing administration course serve as a convenient sample and was divided randomly into two groups; control and study group, each group (No. =78). **Tools:** Three tools were utilized to gather the data; Mind mapping questionnaire, cognitive achievement questionnaire and Yoon's critical thinking disposition instrument. **Results**: The majority of nursing students in the study group (89.7%) had a satisfactory level of knowledge about mind mapping immediately after applying it. Moreover, a satisfactory level of cognitive achievement was also achieved by the majority of nursing students (85.9%) and almost one third of them (32.1%), in the study and control groups, respectively. Additionally, (84.6% & 50%) of the nursing students in the two groups immediately following the application of mind mapping demonstrated high and moderate levels of critical thinking, respectively. **Conclusion:** The correlation between the total scores for both groups' critical thinking and cognitive achievement was highly statistically significant positive. The study suggested expanding the use of mind mapping in additional nursing courses and increasing faculty members' awareness on its use**.**

Keywords: Cognitive achievement, Critical thinking skills, Mind mapping, Nursing students.

Introduction

The complexity of health care is becoming more prominent as the aging population is increasing and requiring extensive health care services. While there are clear advances in treatments, medications, and equipment, the level of acuity is increasing **(Smith, 2016)**.

With the ever-changing health care system, the challenge of education in 21st century is to create human resources who are globally competitive, and this necessitates that nursing students possess the competence, knowledge, and skills necessary to support their activities in the workplace. In learning, the creative technique of mind mapping (MM) can help nursing students to remember and process information **(Astriani et al., 2020)**.

Tony Buzan, a renowned British psychologist, introduced mind mapping, commonly referred to as the brain or the mind map, in the ***1960s*** as a creative way to think **(Liu et al., 2018; Wu and Wu, 2020)**. It is a non-linear learning method that uses a central image to symbolize a key idea or problem before branching out into numerous branches where more ideas are connected to it in a manner similar to how the human brain works (**Su et al., 2021**).

There are two sorts of mind maps: *1. Traditional mind maps* that are manually created on paper and a pen or on a white board, and *2. Electronic mind maps* that use computer software to apply the same methods and create flow branches of ideas that originate from the central one. Additionally, concepts can be changed or moved, and symbols and images can be added (**Aljaser, 2017**).

The following are the four main attributes or principles of MM: (1) the focus of attention is crystallized in a central image; (2) The subject's primary themes radiate outward from the core image like branches of a tree; (3) Each branch has a key symbol or word printed on an associate line; and (4) The branches join to form a nodal structure (**Fauzi et al., 2018; Swestyani et al., 2018; Fearnley, 2022)**.

There are various steps involved in creating a mind maps, including: (1) Take a piece of white paper and turn it into a landscape orientation, (2) Next, begin by creating a colored image in the center of the paper and put the key word in capital letters, (3) pick a color and create the mind-primary mapping's themes on the thick branches extending from the center of the image, (4) add more branches for secondary themes all across the map, (5) Create broad, colorful branches that extend from your mind map, (6) Write simple concepts about the keyword while using capital letters, (7) Use graphics to visualize every significant key phrase on your map and add images to all the main branches to symbolize each key subject, and (8) Allow your mind mapping to be as creative as you can (**Bawaneh, 2019; Nasution, 2020**).

Nursing students can use mind maps to visualize and articulate concepts, explain linkages between concepts, build relationships between diverse ideas, foster critical thinking, and encourage increased involvement in learning activities (**Lacurezeanu et al., 2018; Suherman et al., 2021; Shi et al., 2022**).

Also, mind mapping is the easiest way to put information into the brain and retrieve it out of the brain (**Prastiwi et al., 2018**). Furthermore, it helps learners to learn more effectively, support and enhances their ability to solve a problem creatively. As a graphic organizer, mind maps summarize information in a format that the mind finds easy to recall hence supports remembrance (**Nyagblormase et al., 2021; Tatipang et al., 2021; Tavares et al., 2021**).

As well, Mind mapping taking learners' differences into account, triggering learners' motivation towards learning, presenting data in an interesting and fascinating way, operating and activating the brain parts, providing learners with a generic view of the topic (**Bawaneh, 2019**). Moreover, it facilitates the achievement of a conceptual understanding of a huge amount of information, integrating concepts together, as well as promoting inquiry and reflection (**Atia, 2017**).

Besides, mind maps can be used to develop the cognitive domain among nursing students since it contains learning skills predominantly related to mental processes. Cognitive domain includes the acquisition of knowledge and learning processes **(Farrag, 2017)**. Furthermore, MM is used for many reasons such as students' academic achievement assessment and evaluation, for improving students' knowledge retention, cognitive skills and critical thinking (**Abbas et al., 2018**).

Critical thinking (CT) is the mental active process and subtle perception, analysis, synthesis and evaluation of information collected or derived from observation, experience, reflection, reasoning or the communication leading to conviction for action (**Papathanassiou et al., 2014**). Also, CT refers to a person's decision-making process, which calls for sophisticated higher order thinking skills in order to make intentional self-awareness and self-adjustments. Additionally, CT is the art of thinking in which the thinker enhances the quality of their own thinking by deftly assessing and evaluating their own decision-making processes (**Chou et al., 2019**).

Critical thinking is very important to be mastered so that nursing students can avoid fraud, indoctrination, and mind washing. Also, CT is necessary to assist nursing students improve their ways of thinking and prepare them for success in facing life, helping students become flexible and adaptive in the information era. By thinking critically, someone will have a deep understanding of the problems he or she wants to solve, analyze and solve the problem, ask questions, discover new answers, find recent

information, and oppose dogma and doctrine **(Redhana and Sudria, 2019)**.

It is the responsibility of nurse educators to create learning experiences that encourage critical thinking and greater learning. Nursing students can study in a novel approach that helps improve memory recall and help develop new environments for processing information by using mind mapping. This strategy was created for assisting nursing students to organize and clarify their thoughts by mentally mapping words or concepts (**Atia, 2017**).

Significance of the study

Changes and renewal influence the success of education in all components of education. The curriculum, facilities, infrastructure, teachers, students, and appropriate teaching models are among the components that affect how education is implemented. All of these components work together to promote the targeted educational objectives (**Taadi et al., 2019**)

The field of nursing education has experienced many progressive phases, reforms, and challenges throughout the past three decades. One of the challenges is coming up with innovative teaching methods to help nursing students' critical thinking abilities. Despite nursing educators carefully planning the most appropriate content to empower their students, teaching strategies and methods have several flaws. With little to no focus on the methods used by students in their learning process, there is a strong emphasis on learning outcomes. Consequently, a thorough reevaluation of undergraduate nursing curricula and associated teaching and learning methods is required (**Khrais and Saleh, 2017; Khrais and Saleh, 2020**). So, this study was carried out to evaluate the effect of mind mapping on cognitive achievement and critical thinking skills of nursing students.

Aim of the study

In this study, we aimed to investigate the effect of mind mapping on cognitive achievement and critical thinking skills of nursing students through:

1. Assessing nursing students' knowledge about mind mapping.
2. Assessing nursing students' cognitive achievement level.
3. Assessing nursing students' critical thinking skills.
4. Finding out whether mind mapping affecting nursing students' cognitive achievement and critical thinking skills.

Research hypotheses

- Mind mapping will enhance cognitive achievement of nursing students.
- Mind mapping will enhance critical thinking skills of nursing students.

2. Subjects and Methods

2.1. Research Design

A Quazi- experimental research design (pre\post intervention control group) was utilized to attain the study's aims.

2.2. Setting

The study was conducted at Faculty of Nursing, Al -Azhar University in Nasr city, Cairo where one of the researchers was seconded there.

2.3. Subjects

2.3.1. Subject Type

A convenient sample

2.3.2. Subject Size

This study included all 156 female students in the third year for the academic year 2021-2022, 2nd term who signed up for the nursing administration course and were divided randomly into two groups; control and study group (the experimental group), 78 nursing students were assigned to each group. The study group's lectures were based on mind mapping, while the control group got instruction using traditional methods.

2.4. Tools of Data Collection

Three tools were utilized for gathering the data of this study:

Tool I: Mind mapping questionnaire: It consists of two parts;

***Part one*:** It included the personal characteristics of nursing students (age, gender, marital status).

***Part two*: Mind mapping questionnaire:** it was developed by the researchers in the light of literature (**Abbas et al., 2018; Bawaneh, 2019; Nasution, 2020; Tatipang et al., 2021; Tavares et al., 2021**) to assess the nursing students' (study group) knowledge about mind mapping through 16 questions divided into: true or false questions (6 questions) and multiple-choice questions (10 questions).

Scoring system:

Subjects' responses were scored as a mark for the correct answer and zero for the incorrect one (total 16 marks). Based on a range of scores (0–16), the knowledge of nursing students was classified as having a satisfactory level ≥ 60% and an unsatisfactory level < 60%.

Tool II: Cognitive achievement questionnaire: This tool was developed by the researchers based on reviewing the related literature to measure the nursing students' (study & control group) cognitive achievement level. The twenty-question questionnaire covered four subjects from the Nursing Administration course (Communication, discipline, supervision and career development) and had 12 true or false questions and 8 multiple-choice questions

Scoring system

Answers to subjects were graded with one mark for a correct response and zero for a wrong one. The whole questionnaire was added up, and the mean score was used to determine the results. The knowledge of nursing students was rated as being at a satisfactory level ≥ 60% and an

unsatisfactory level < 60% using a range of values from (0-20).

Tool III: The Yoon's Critical Thinking Disposition Instrument: it was created by (Yoon, 2004) to assess the critical thinking skills of nursing students in the study and control groups. The 27 items in this tool were divided into the following seven domains: Confidence (4 items), Eager (5 items), Fairness (4 items), Objectivity (3 items), Prudence (4 items), Skepticism (4 items), and Systematicity (3 items).

Scoring System:

The responses of the subjects were rated on a five Likert scale that ranged from strongly agree (5), agree (4), natural (3), disagree (2), and strongly disagree (1). The Items' scores were summed-up and the total divided by the number of items, then these scores were converted into a percent score. The critical thinking skills was considered high if the percent score was more than 75%, moderate if the percent score ranged from 60 to 75%, and low if the percent score was less than 60%.

2.5. Tools validity and reliability

A panel of three nursing administration professionals assessed the study's tools to assess their content validity, coverage, clarity, completeness, and applicability. The necessary adjustments were made in accordance with their suggestions. The Cronbach's alpha coefficient test, which was used to determine reliability, showed that the instrument was made up of generally homogeneous elements. The mind mapping questionnaire, cognitive achievement questionnaire and the Yoon's critical thinking disposition instrument all have Cronbach's alpha values of 0.756, 0.869, and 0.852, respectively.

2.6 Ethical Considerations

The Dean of the Nursing Faculty at Al-Azhar University gave her official consent. All of the students gave their oral agreement after the researchers had fully explained the aim and design of the study. The students were also assured that the results would only be utilized for research and would not have any effect on their final grades.

2.7 Pilot study

In order to check the suitability, clarity, and application of the study tools, the researchers ran a pilot study on a group of 16 nursing students from the study group (representing 10% of the sample). They were included into the study sample because there was no change performed.

2.8 procedures

This study was conducted through 4 phases; Assessment, planning, implementation, and evaluation.

2.8.1 Assessment phase

The researchers welcomed and spoke with nursing students during this phase. Then, they described the study's aims and methodology to students. Additionally, the researchers divided the nursing students into two groups (78 experimental/study group and 78 control group).

Pre-test was done for two groups via electronic forms (Google-forms tool), which is commonly used by researchers for collecting data. The web-based questionnaires were distributed through Whatsapp designed to each group to collect the relevant data. For the control group (Tool I part 1, II and III) and the study group (Tool I, II, and III). In November 2021, the data collection process (pre-test) was completed.

2.8.2 Planning phase

Based on baseline data obtained from pre-test assessment and relevant review of literature, the content was developed by the researchers. It included four topics related to nursing administration course; Communication, discipline, supervision and career development. The researchers prepared the content by traditional method for control group and the same content prepared by mind mapping method for study group. A power point presentation of the themes was also made by the researchers. For the study group, mind mapping instructions were also prepared. From the beginning of December 2021 until the end of January 2022, two months were spent completing this phase.

2.8.3 Implementation Phase

The implementation phase was completed through sessions. For control group, the researchers taught content using traditional method. For the study group, the researchers first provided nursing students with orientation sessions on mind mapping. These lessons covered terminology, types, advantages, principles, and steps. The mind mapping method was then used by the researchers to teach. There was just one topic covered in each session's two hours of instruction. This phase was carried out from the mid of February, 2022 and throughout the 2nd semester.

2.8.4 Evaluation Phase

To assess the effect of the implemented intervention, a post-test using the same format as the pre-test was administered at the end of the second semester. It took place in May, 2022.

2. 6. Statistical Design

All data were gathered, coded, tabulated, and statistical analysis was performed on them. Microsoft Office Excel is utilized for data handling and graphical presentation, while the Statistical Package for Social Sciences (SPSS) version 20.0 was used for statistical analysis. The use of descriptive statistics was used (e.g., mean & standard deviation). Using the chi-square test, qualitative categorical variables were compared. Between variables, the Pearson correlation coefficient was determined. A p-value of ≤ 0.05 was used to determine statistical significance, and a p-value of ≤ 0.001 was used to determine highly significant significance. Using two samples as the control and study groups, parametric tests, such as the independent (t) test, was used to compare the mean scores.

Results

Table (1): Shows that nursing students had a mean of age 20.85 ± 0.81 & 21.11 ± 0.74 in both groups (study and control) respectively.

Regarding their gender and marital status, all of nursing students (100.0% were female and single in both groups.

Figure (1): Illustrates that, before application two thirds of nursing students (66.7%) of study group had unsatisfactory level of knowledge about mind mapping. Meanwhile, immediately post application of mind mapping the majority of nursing students (89.7%) had satisfactory level of knowledge about mind mapping. Also, there was statistically significant improvement regarding nursing students' knowledge about mind mapping in study group.

Table (2): Represents that before application, there was no statistical significant difference between study and control group regarding nursing students' cognitive achievement. Meanwhile, Higher overall mean scores in the study group than the control group (17.74±2.13 & 15.19±2.84, respectively) were obtained immediately after the application of mind mapping between both groups, indicating a highly statistically significant difference improvement ($P \leq 0.001$). This table demonstrates clearly that using mind mapping instead of a traditional method improved nursing students' cognitive achievement regarding discipline, career development, communication, and supervision.

Figure (2): Illustrates that, before application more than three fifth of studied nursing students (64.1% &71.8%) at study and control group had unsatisfactory level of cognitive achievement respectively. Meanwhile, immediately post application most of nursing students (85.9%) and nearly one third of them (32.1%) in the study and control groups had satisfactory levels of cognitive achievement respectively. It is clear from the study's findings that the mind mapping group achieved higher levels of cognitive achievement than the control group right after application.

Table (3): Represents that, before application there was no statistical significant difference between study and control group of nursing students' critical thinking skills. Meanwhile, higher overall mean scores in the study group than the control group (104.29 ±7.94 & 86.27 ±7.32) respectively were detected in the immediate post application between both groups, indicating a highly statistically significant differential improvement ($P \leq 0.001$). This table makes it quite clear that using mind mapping improved nursing students' critical thinking skills more than using traditional methods.

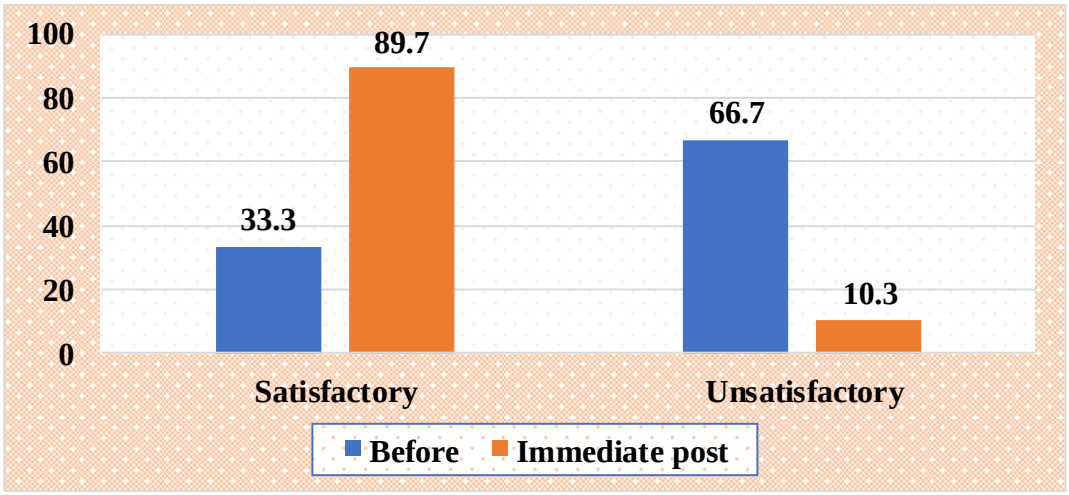
Figure (3): Shows that, before application the majority (75.6% & 89.7%) of the studied sample of nursing students had low level of critical thinking skills in both groups (study and control) respectively. Meanwhile, (84.6% & 50%) of the nursing students of the two groups had high and moderate level of critical thinking respectively immediately post the application. This indicates that the improvement of critical thinking among the study group was higher than the control group.

Table (4): Illustrates that there was highly statistically significant positive correlation between total cognitive achievement score and total critical thinking score at both groups (P ≤ 0.001).

Table (1) Distribution of the studied sample in study and control groups according to personal characteristics (n=156)

Groups / Variables	Study group n=78		Control group n=78		X^2	P-value
	No	%	No	%		
Age (years)						
< 21	30	38.5	21	26.9	2.360	0.125 ns
21-24	48	61.5	57	73.1		
Mean ± SD	20.85 ± 0.81		21.11 ± 0.74		t=1.242	0.216ns
Gender						
Female	78	100.0	78	100.0	-	-
Marital status						
Single	78	100.0	78	100.0	-	-

ns no statistically significant difference (p > 0.05) **t= independent t test**



X2= 136.525 P value = 0.000

Figure (1): Distribution of nursing students in the study group according to knowledge about mind mapping before and immediately post application of mind mapping

Table (2): Comparison of mean scores of nursing students' cognitive achievement between study and control groups before and immediately post application of mind mapping (n=156)

Groups / Variables		Study group n=78	Control group n=78	Independent t-test	P value
	Time	Mean ±SD	Mean ±SD		
Discipline	Before	1.75 ± 1.58	1.56± 1.42	0.853	0 395^{ns}
	Immediate post	4.38 ± 0.91	3.75± 1.19	3.703	0.000**
Career development	Before	1.35 ± 2.16	1.18± 1.94	0.519	0.604 ^{ns}
	Immediate post	4.35 ± 0.82	3.94± 0.83	3.113	0.002*
Communication	Before	1.43 ± 2.19	1.1154± 2.16	0.952	0.343 ^{ns}
	Immediate post	4.45 ± 0.91	3.42 ± 0.87	7.186	0.000**
Supervision	Before	1.67 ± 1.26	1.56 ± 0.97	0.638	0.524 ^{ns}
	Immediate post	4.56 ± 0.68	4.15 ± 0.84	3.364	0.001**
Total score	Before	6.22 ± 4.71	5.41 ± 3.55	1.209	0.228 ^{ns}
	Immediate post	17.74 ± 2.13	15.19 ± 2.84	6.529	0.000**

^{ns} no statistically significant difference (p > 0.05) t= independent t test

A statistically significant difference (P ≤ 0.05) **A highly statistically significant difference (P ≤ 0.001)
^{ns} no statistically significant difference (p > 0.05)

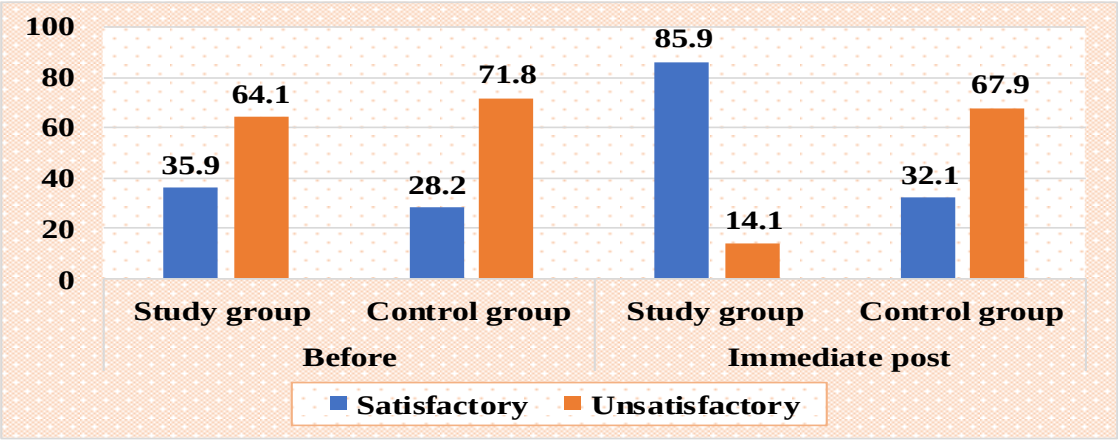


Figure (2): Distribution of nursing students in the study and control groups according to cognitive achievement level before and immediately post application of mind mapping

Table (3): Comparison of mean scores of nursing students' critical thinking skills between study and control groups before and immediately post application of mind mapping (n=156)

Groups / Variables		Study group n=78	Control group n=78	Independent t-test	P value
	Time	Mean ±SD	Mean ±SD		
Confidence	Before	11.67 ± 2.89	11.43± 2.90	0.498	0.619^{ns}
	Immediate post	14.91 ± 1.71	12.72 ± 2.61	6.246	0.000**
Eager	Before	15.63 ± 3.41	14.38 ± 5.14	1.780	0.077 ^{ns}
	Immediate post	19.95 ± 2.01	15.43 ± 4.64	7.874	0.000**
Fairness	Before	12.18 ± 3.02	11.98 ± 3.71	0.355	0.723 ^{ns}
	Immediate post	16.07 ± 1.72	11.71 ± 2.77	11.819	0.000**
Objectivity	Before	10.92 ± 1.75	10.59 ± 2.07	1.087	0.279 ^{ns}
	Immediate post	12.03± 1.03	11.03 ± 1.68	4.475	0.000**
Prudence	Before	11.13 ± 2.46	10.88± 2.22	0.650	0.517 ^{ns}
	Immediate post	13.37 ± 2.43	11.04± 2.03	6.504	0.000**
Skepticism	Before	12.27 ± 3.06	12.13 ± 3.23	0.534	0.594 ^{ns}
	Immediate post	15.21 ± 1.49	12.71 ± 2.54	7.491	0.000**
Systematicity	Before	8.68 ± 2.28	8.37 ± 1.35	1.025	0.307 ^{ns}
	Immediate post	12.76 ± 2.27	9.68 ± 1.69	9.613	0.000**
Total score	Before	82.47 ± 8.61	79.65 ± 16.69	1.327	0.187 ^{ns}
	Immediate post	104.29 ± 7.94	86.27± 7.32	14.749	0.000**

**A highly statistically significant difference (P ≤ 0.001) ^{ns} no statistically significant difference (p > 0.05)

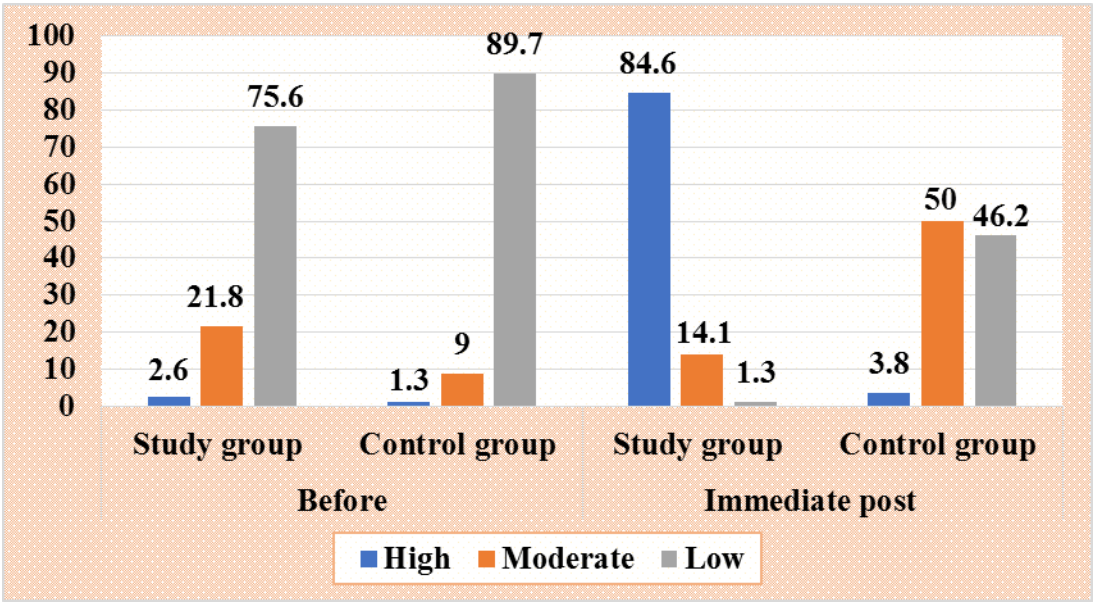


Figure (3): Distribution of nursing students in the study and control groups according to critical thinking skills level before and immediately post application of mind mapping

Table (4) Correlation coefficient between total cognitive achievement and critical thinking scores between study and control groups before and immediately post application of mind mapping (n=156)

Variables		Total cognitive achievement score			
		Study group		Control group	
		r	p	r	p
Total critical thinking score	Before	0.613	0.000**	0.560	0.000**
	Immediate post	0.750	0.000**	0.677	0.000**

****A highly statistically significant difference (P ≤ 0.001)**

Discussion

Lately, engaging students in their learning process becomes a challenge for faulty members. In today's educational communities, it is important to redesign learning approaches in order to achieve the college students' needs for a respectable and engaging environment for learning **(Rosciano, 2015)**. Mind map has been used to portray facts in medical information and become popular as educational material with the aim of improving memory. It can be used as a self-learning method that facilitates the understanding of difficult concepts **(Mohammed et al., 2022)**.

According to personal characteristics of the current study's participants, results showed that nursing students had a mean of age 20.85 ± 0.81 & 21.11 ± 0.74 in both groups (study and control) respectively. In terms of gender and marital status, all nursing students in both groups were female and unmarried. From the researchers' point of view the participants of both groups were similar and this similarity was important for fair comparison. These finding agreed with **(Elsayed et al., 2022)** who revealed that the students of the both groups had about the same median age. In the same line, **(Wu & Wu, 2020)** showed that their participants of students age range from 21-23 years; but there was disagreement that the majority of participants were female; in addition, slightly above the half were undergraduate university students and less than the half of them were junior college students.

The findings of the present study demonstrated that there was a statistically significant improvement in nursing students' knowledge about mind mapping after applying it. This may be due the novelty of mind mapping as a learning strategy and orientation sessions causes this improvement of knowledge. Also, it indicates

that information given to them was attractive. This result supported by **(Mustafa, Keshk & Helal, 2022)** who mentioned in their study results that about four fifth of their studied nursing students had satisfactory knowledge about mind mapping and the satisfactory to unsatisfactory knowledge level ratio was 3.8:1.

Also, there was an agreement with **(Rosciano, 2015)** who indicated that who revealed that the participants of associate nursing students expressed that mind mapping helped to keep their ideas focused and they had a clearer understanding of the MM concept. Likewise **(Youssef & Mansour, 2012)** revealed that the majority of baccalaureate nursing students understand and accept the concept of min mapping.

Concerning the impact of mind mapping on students' cognitive achievement; the findings of the current study demonstrated that there was a highly statistically significant improvement in cognitive achievement between the study and control groups immediately following the application of mind mapping, with higher total mean scores in the study group than the control group. This may be due to enhancing the student's ability of analyzing, link between ideas which improve the student's comprehension and rapid recall of information of the contents through using mind maps. This result was in agreement with **(Wu & Wu, 2020)** who indicated that mind mapping strategy enhanced their desire for acquiring knowledge.

On the same line (**Kaddoura, Van-Dyke & Yang, 2016)** showed that students in mind mapping group obtained higher cognitive score than those of the control group. Also, (**Jaafarpour et al., 2016)** they showed that the mean scores of all tests were higher in the mind mapping group compared to the group who only take quizzes. Also, mind mapping group demonstrated gradual improvement throughout the eight sessions of the intervention. Additionally, (**Youssef & Mansour, 2012)** illustrated that implementing a mind mapping strategy in the nursing education can significantly increase students' learning achievement.

In addition, **(Kireeva, 2019)** revealed that there was academic improvement among the students using mind maps and they also showed deeper understanding and learning than the group using conventional methods. Moreover, this finding was consistent with **(Mohammed et al., 2022)** who pointed out that the majority of nurses had improved their knowledge regarding infection control precautions post-intervention than pre-intervention. But, this finding was in contrast to **(D'Antoni et al., 2010)** who reported that mind mapping was not superior for the short-term recall of domain-based information to the standard note taking group.

Regarding comparison of mean scores of nursing students' critical thinking skills between study and control groups before and immediately post application of mind mapping; the results revealed that higher total mean scores between

both groups immediately following application showed a highly statistically significant improvement in the students of study group than control group. This may be due to the active participation of the students of the study group in their learning process, where they were allowed to draw mind maps with their hands and this led to improve their thinking and increase their self-confident. In contrast, the students of control group were a passive recipient through their learning process.

This result supported by **(Elasrag & Elsabagh, 2020)** who stated in their results that there was a highly statistically significant differences regarding all domains of critical thinking between pre and post mind mapping application. Also, similarly this finding was congruent with **(Israel, 2019)** who represented that the physician assistant students group who use mind maps showed higher scores of their critical thinking skills than standard note taking group of students post intervention of nine weeks. In contrast, this finding was incongruent with **(D'Antoni, 2009)** who reported that mind mapping didn't promote greater critical thinking compared to the standard note- taking group

Current study results showed that, the majority of studied nursing students of both groups had low level of critical thinking, meanwhile, the students of study and control group had high and moderate level of critical thinking respectively immediately post the application of mind mapping. This may be due to stimulation of thinking and connecting of ideas which mind maps allow. This result was consistent with **(Wu & Wu, 2020)** they pointed out that nursing students' inclination toward clinical thinking was improved significantly after mind mapping application compared with that of pre intervention. But this differs with (**D'Antoni et al., 2010)** who investigated if a relationship exists between mind mapping and critical thinking, and they found no significant differences in either critical thinking or content knowledge scores on the pre- and post-quizzes between the two types of note taking groups.

Concerning the correlation between cognitive achievement and critical thinking scores between study and control group before and immediately post application of mind mapping. The results represented that there was highly statistically significant positive correlation between both total cognitive achievement and critical thinking score. This may be due to the greater the student's ability to think critically, the higher the internal motivation to learn and this leads to increase the cognitive achievement and vice versa.

. In the same track, this result was consistent with **(Safitri et al, 2018)** who mentioned that there was a positive correlation between critical thinking and cognitive achievement among their participants of students. Likewise**,** Similarly, this result matched with **(Wilgis & McConnell, 2008)** who revealed that using mind maps during orientation program of graduate nurses assisted them in connecting knowledge together,

enhancing prioritization and organization of patient care planning and improving critical thinking.

Conclusion

In the light of the foregoing present study results, it can be concluded that study group who used mind mapping method reported high satisfactory level of cognitive achievement than control group immediately post application. Also, mind mapping strategy enhanced nursing students' critical thinking skills more than traditional method as improvement of critical thinking among the study group was higher than the control group. Furthermore, post application of mind mapping there was highly statistically significant positive correlation between total cognitive achievement score and total critical thinking score at both groups.

Recommendations

In the light of the findings obtained from the present study, the following recommendations are suggested:

1. Nursing faculties should evaluate their curricula and incorporate mind maps in teaching the courses
2. Raise faculty members' awareness by holding several seminars and training sessions on the use of mind mapping and expanding its application in other nursing courses.
3. Train and encourage nursing students to take notes during lectures and clinical practice sessions using mind maps
4. Encouraging the academics to use teaching strategies that would enhance students' cognitive development and critical thinking

Future research are suggested

1. Repeat the current study on a larger probability sample to achieve generalization in different nursing faculties.
2. Conduct study to determine how different innovative teaching techniques affect nursing students' cognitive achievement and critical thinking abilities.
3. Examine the long-term impact of using mind mapping on cognitive achievement and critical thinking of nursing students

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