

## Effectiveness of Using Mind Mapping within Flipped Classroom Strategies on Cognitive Achievement, practical skills and satisfaction of Nursing Students

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### Abstract

**Background:** As nursing education shifts from passive to active, it is important to adopt modern teaching strategies. Flipped classes and mind mapping enhance students' ability to apply and retain content. **Aim:** This study was conducted to assess the effectiveness of using mind mapping within flipped classroom strategies on the cognitive achievement and practical skills of nursing students. **Method:** A randomized trial was conducted on 320 nursing students to examine the effect of two collaborative teaching strategies: mind mapping combined with flipped classroom versus the conventional blended method of a flipped classroom with traditional lecture. This study used three tools: a cognitive achievement test included two parts, one about personal characteristics and the other related to cognitive achievement; a self-rating scale of self-directed learning (SRSSDL), and a structured student' satisfaction and self-confidence in learning scale (SSSCL). **The results** showed that there were insignificant differences in cognitive achievement, self-directed learning skills, satisfaction, and self-confidence scores before the intervention ( $P > 0.05$ ). However, after the application of teaching methods, study group 1 showed significantly higher scores in cognitive achievement, self-directed learning skills, satisfaction, and self-confidence compared to study group 2. **Conclusion:** The combination of a collaborative mind mapping strategy and a flipped classroom significantly improved students' cognitive achievement and self-directed learning skills more than the conventional blended methods. **Recommendation:** The study suggests that the collaboration of flipped classroom and mind-mapping techniques should be implemented as effective teaching methods for nursing students' education.

**Keywords:** Cognitive Achievement, Flipped Classroom, Mind Mapping, Satisfaction & Self-Directed Learning

### Introduction:

Students in nursing education now have the opportunity to apply their knowledge in clinical settings through various instructional approaches, such as blended learning, collaborative learning, and active learning, with the help of tools like mobile learning, teaching platforms, and online resources, students can learn theory and gain practical experience through reviews and discussions (Chu et al., 2019; Nwamu, & Ni, 2023). As a result, students' attitudes toward learning and cognitive proficiency in theoretical and practical subjects may improve. Additionally, in face-to-face classes, groups can learn the skills required to solve complex problems, and later, mobile learning can help consolidate newly acquired skills and knowledge (Chao et al., 2022). The ability to problem-solve and actively participate are essential skills in research methodology education (Chang et al., 2022). Research methodology, a compulsory curriculum in the field of public health sciences, is a subject that ensures students' competence necessary for reading and understanding research articles, foundational skills in undergraduate research training.

It is a mainstream curriculum for nursing students and aims to cultivate students' logical thinking and problem-solving abilities (Helgøy, et al., 2022).

Despite the research methodology course importance, many nursing faculty members find the subject difficult to understand and apply. Traditional teaching methods may meet undergraduate students' learning needs but are lacking in stimulating students' learning initiative and active thinking ability in practical work, challenging to meet the demands of modern society for public health and preventive nursing skills (Chang et al., 2022). Therefore, blending more modern teaching approaches will enhance the effectiveness of the research methodology learning process and lead to higher academic achievement. Based on this concept, academic literature recommends blending the flipped classroom with mind mapping methods (Nugroho, et al., 2020 & Liu et al., 2022).

The "flipped classroom" is a new instructional strategy that "flips" the conventional teaching process. In this model, students first acquire knowledge independently before internalizing it

through interactions with peers and teachers. As a result, teachers shift from serving as information providers in the traditional classroom to facilitators and instructors. Flipped classrooms have gained popularity in blended learning techniques in recent years, and they have proven to be more successful for adult learners than traditional didactic lectures in terms of multidisciplinary practice and application (Wang, 2021&Zhang, 2022).

A tool for putting divergent thinking into concrete form is the "mind map." It makes use of vocabulary, lines, symbols, and images to create divergent and nodal structural forms. The tool further transforms tedious text data into hierarchical maps in order to increase learners' information storage and extraction, as well as their productivity at work and in class. It uses graphical and textual representation to show the relationships of topics at all levels using pertinent hierarchical diagrams. The mind map can also be used as a teaching tool to encourage learners to integrate knowledge across disciplines, understand the relationship between basic science and clinical science, and advance nursing education (Liu et al., 2022).

Additionally, the importance of practical research methods skills, academic achievement, and self-directed learning abilities, which cannot be achieved by ineffective traditional methods, is taken into consideration. This is especially important given the lack of research in the database about using the flipped classroom with mind mapping approaches. Therefore, we conducted a randomized trial in teaching practice to evaluate the effectiveness of using mind mapping within flipped classroom strategies on the cognitive achievement, practical skills and satisfaction of nursing students regarding research methodology.

#### **Aim of the study:**

To evaluate effectiveness of using mind mapping within flipped classroom strategies on cognitive achievement, practical skills and satisfaction of nursing students.

#### **Method:**

##### **Research design:**

This study was conducted through randomized education intervention trial.

##### **Research hypotheses:**

To achieve the study's aim, the following research hypotheses were developed:

**H<sub>1</sub>:** The post-mean cognitive achievement score regarding the research methodology in study group 1 would be significantly higher than in study group 2.

**H<sub>2</sub>:** The post-mean self-directed learning (SDL) skills score in study group 1 would be significantly higher than in study group 2.

**H<sub>3</sub>:** The post-mean satisfaction and self-confidence scores in the learning process for study group 1 would be significantly higher than those of study group 2.

#### **Settings:**

The study was conducted at the faculty of nursing affiliated to Mansoura University.

#### **Subjects and sampling technique:**

The study subjects were 3rd and 4th level nursing students of both genders who signed up for the research methodology course for the academic year 2023-2024, 2nd term, and accepted to participate in the study.

The entire sample was split into two groups, each group with 160 students, using a simple random technique with the aid of the random number generation function of commercially available mobile software (random number generator Pro). Study group 1 was assigned number one (who received the research methodology course using mind mapping within the flipped classroom method), and study group 2 was assigned number two (who received the research methodology course using traditional blended methods).

#### **Sample size calculation:**

Sample size was calculated using the two independent groups formula of the **ClinCalc Statistical Software**, considering the confidence level (95%), the test power (80%), and based on the primary outcome variable in the study of **El-Sayed, et al., (2023)** with the mean and standard deviation in study group 1 (M= 82.47 and SD = 8.61) and study group 2 (M = 79.65 and SD = 16.69). Therefore, the minimum acceptable sample size was determined to be 145 students for each group. An additional 10% was added to account for potential participant dropouts, resulting in a final sample size of 160 students for each group.

#### **Data collection tools:**

Data collection was accomplished by using three tools.

**Tool I: A self-administered cognitive achievement test.** This tool included two parts. The first part involved the baseline personal characteristics of nursing students, such as age, gender, academic level, previous GPA score, and residence. The second part included questions to assess the cognitive achievement of the student in the research methodology course, such as the main research concepts, importance of research, the research process, types of research designs, different tools and methods of data collection, and ethics of doing research. These questions were developed based

on related academic sources (Charumbira, et al., 2022).

**Scoring system:**

Each correct answer was scored (1), and an incorrect answer or don't know was scored (0). The total knowledge score is converted to a percentage and classified based on Amr, et al., (2023) study: high level ( $\geq 75\%$ ); moderate level ( $50\% - <75\%$ ); and low level ( $<50\%$ ) of the total score.

**Tool II: Self-Rating Scale of Self-Directed Learning (SRSSDL).** This tool was created by Williamson (2007) to measure the skill level of self-directedness in the higher education learning process, enabling students to become independent lifelong learners. It includes 60 items arranged under five domains as follows: learning awareness (12 items relating to learners' understanding of the factors contributing to becoming self-directed learners; learning strategies (12 items explaining the various strategies used by self-directed learners); learning activities (12 items specifying the requisite learning activities learners should actively engage in to be self-directed); evaluation (12 items revealing learners' specific attributes to evaluate their learning activities); and interpersonal skills (12 items relating to learners' skills in inter-personal relationships, which are prerequisites to being self-directed).

**Scoring system:**

Responses for each item are scored on a five-point Likert scale ranging from never (1) to always (5). SLD is categorized based on Abdelhafez, et al., (2020) cut off points as: low level when the learner achieves a score of 60-140, moderate level with a score of 141-220, and high level with a score of 221-300 ()

**Tool III: Student Satisfaction and Self-Confidence in learning Scale (SSSCL).** This scale was developed by The National League for Nursing (NLN) in collaboration with Laerdal medical organizations (Jeffries, & Rizzolo, 2006). The tool is composed of 13 items arranged into two sections. The first section includes five items to evaluate students' satisfaction with the Mind Map and flipped classroom technique as a teaching-learning method, while the second section involves eight items related to self-confidence in using these new techniques.

**Scoring system:**

Each item was measured on a five-point Likert Scale, with (0) indicating strongly disagree and (5) indicating strongly agree. The total satisfaction and self-confidence score was classified based on Mohamed & Mohamed (2020) cut off points as follows: high level ( $68\% - 100\%$ ); moderate level

( $52\% - 67.9\%$ ); and low level ( $20\% - 51.9\%$ ) of the total score.

**Tools validity and reliability:**

A group of five experts in maternal and newborn health and community health nursing evaluated the content validity of the study's tools to determine their coverage, completeness, and applicability. In a pilot study with 10% of the total sample size of the students (32), who were excluded from the studied sample, evaluated the suitability, clarity, and applicability of the study tools. Accordingly, the researchers made the necessary adjustments based on feedback from the professionals and piloted students. The researchers used Cronbach's alpha coefficient test to determine the reliability of the study tools. The Cronbach's alphas for the overall SSSCL and the subscales of students' satisfaction and self-confidence were 0.95, 0.96, and 0.92, respectively, indicating excellent reliability in this study. In addition, the Cronbach's alpha coefficient of the Scale of Self-Directed Learning was determined to be acceptable (0.78).

**Ethical considerations:**

The research ethics committee of Mansoura University's nursing faculty granted its approval in accordance with ethical standards. After the researchers thoroughly explained the study's purpose and design, verbal informed consent was also guaranteed to the students, assuring them that the results would not affect their final grades and would only be used for research.

**Procedure:****Administrative steps:**

An official approval to conduct the study was obtained from vice dean for education and students affairs of the faculty of nursing affiliated to Mansoura university to conduct this study, explaining the study's aim and procedures together with its potential benefits.

**An operational procedure:**

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

**Assessment phase:**

The researchers welcomed nursing students and explained the study's aims and methodology to them. They distributed the course syllabus, including learning goals, timetable, and tasks. Additionally, the researchers randomly allocated the nursing students into two groups (160 study group 1 and 160 study group 2) using mobile randomizer software. The researchers collected the baseline personal characteristics, cognitive achievements, and self-directed learning skills from the two groups using

**Tools I and II.****Planning phase:**

Based on preliminary data obtained from pre-test findings and relevant academic literature, the researchers developed the course content. The content included six topics related to research methodology: basic concepts, importance and uses of research, research process, types of research designs, different tools and methods of data collection, and ethics of doing research. The researchers prepared the content for the study group 2 using conventional blended learning methods (mix of lecturing and 15-20 minutes of flipped audio/ video). The same content was prepared for the study group 1 using a collaborative method of mind mapping and 15-20 minutes of flipped audio/video. For the study group 1, an introductory Power Point Presentation (PPT) of mind mapping instructions was also prepared to familiarize them with using this technique. A Power Point presentation of the themes was also prepared by the researchers to be distributed to both groups.

**The implementation phase:**

This phase was completed within six weeks through six main sessions, with one session each week. Both study groups were taught by the same researcher. Additionally, the content was distributed to both groups on a CD one week before the beginning of the classes to be used as a reference guide.

**For study group 1:**

Each week, a 15-20 minute flipped audio/ video was sent via a WhatsApp group one to two days before the session. During out-of-class learning activities, students individually listened to the flipped videos, read the topic content, and created their own mind maps about the content of the flipped audio/video. Then, in small groups of 16 students, they integrated their mind maps through consultation and discussion to create a collective mind map and gave a short presentation about it. Subsequently, the researcher and the whole class made comments about the presentation. After completing each session's activities, all study group 1 students answered color-coded questions on a cognitive achievement test related to the session content.

**For study group 2:**

Each week, conventional blended learning methods with 15-20 minutes of flipped audio/video were sent via a WhatsApp group one to two days before the session. In addition, a traditional lecture was given at the next session time. For out-of-class learning activities, the students were only asked to listen to flipped videos, and read the topic content. At the end of each session, all group 2 students answered color-coded questions on a cognitive achievement test related to the session content.

**The evaluation phase:**

At the end of the sixth session, all the students from both study groups completed answering a cognitive achievement test. They were also asked to fill out the SRSSDL to evaluate their improvement in self-directed learning skills (practical skills). In addition, they were asked to complete a satisfaction and self-confidence in learning scale to measure their satisfaction level regarding the teaching methods used.

**Statistical analysis:**

Data was coded and analyzed using the Statistical Package for the Social Sciences version 21.0 (SPSS Inc, Chicago, IL). Descriptive analyses using numerical summaries, including measures of central tendency and dispersion, were performed on the research data to describe the sample characteristics. For determining normality, the Kolmogorov-Smirnov test was used. Inferential statistics, including Chi-square and independent t-tests, were used to test the research hypotheses. Additionally, Cohen's d, which measures the effect size of the t-test, was used to measure the size of the intervention effect of the study outcomes. The significance level was set at 5%.

**Results:****Personal characteristics of the studied students:****Table (1): Distribution of the studied students according to their baseline personal characteristics, (n=320)**

Personal characteristics	Total N =320				Significance test
	Study group 1 N=160		Study group 2 N=160		
	No.	%	No.	%	
<b>Age</b>					
18-<20	16	10	23	14.4	0.127
20-<22	118	73.8	113	70.6	
≥22	26	16.2	24	15	
<b>Mean (SD)</b>	21.0(0.83)		20.86(0.85)		
<b>Gender</b>					
Female	100	62.5	89	55.6	0.217
Male	60	37.5	71	44.4	
<b>Academic level</b>					
3 <sup>rd</sup> level	113	73.8	131	81.9	0.08
4 <sup>th</sup> level	42	26.2	29	18.1	
<b>Residence</b>					
Urban	96	60	85	53.1	0.215
Rural	64	40	75	46.9	
<b>Previous total GPA level</b>					
D	2	1.2	00	00	0.641
D <sup>+</sup>	5	3.1	3	1.9	
B	32	20	29	18.1	
B <sup>+</sup>	83	51.9	87	54.4	
A	33	20.6	38	23.8	
A <sup>+</sup>	5	3.1	3	1.9	
<b>Having previous information about mind mapping</b>					
No	127	79.4	139	86.9	0.073
Yes	33	20.6	21	13.1	
<b>Having previous information about flipped classroom strategies</b>					
No	152	95	150	93.8	0.627
Yes	8	5	10	6.2	

$\chi^2$ : Chi square test or Fisher exact tests, t: Independent t-test, \*P<0.05 significant.

**Table (2): Comparison of the mean scores of cognitive achievement before, and after the intervention implementation between the two study groups.**

Items	Study group 1 N=160	Study group 2 N=160	Significance test
	$\bar{x}$ (SD)	$\bar{x}$ (SD)	
<b>Basic concepts of research methodology score=(5)</b>			
Before the intervention	0.88(0.53)	1.04(0.86)	t*=1.78 P=0.076
Post- the intervention	4.26(0.50)	3.03(0.15)	t*=46.00 P≤0.001 d=3.33
<b>Importance and uses of research score=(5)</b>			
Before the intervention	1.34(0.57)	1.25(0.51)	t*= 1.54 P=0.124
Post- the intervention	4.64(0.48)	3.37(0.47)	t*=23.65 P≤0.001 d=2.67
<b>Research process score=(7)</b>			
Before the intervention	1.85(1.01)	2.07(1.23)	t*=1.67 P=0.094
Post- the intervention	6.61(0.59)	3.74(0.82)	t*=35.57 P≤0.001 d=4.01
<b>Research designs score=(10)</b>			
Before the intervention	2.19(0.82)	2.00(0.97)	t*=1.86 P=0.064
Post- the intervention	8.10(0.99)	5.16(0.67)	t*=30.99 P≤0.001 d=3.47



Items	Study group 1 N=160	Study group 2 N=160	Significance test
	$\bar{x}$ (SD)	$\bar{x}$ (SD)	
<b>Different tools and methods of data collection score=(9)</b>			
Before the intervention	1.39(0.93)	1.58(0.90)	t*=1.83 P=0.068
Post- the intervention	6.94(1.23)	5.22(1.44)	t*=11.45 P≤0.001 d=1.28
<b>Ethics of doing research score=(4)</b>			
Before the intervention	0.43(0.41)	0.53(0.50)	t*=1.79 P=0.074
Post- the intervention	2.90(0.97)	2.53(0.50)	t*= 4.33 P≤0.001 d=0.48

t\*: Independent t-test, d: Cohen's d (effect size), P Significance \* Significant (p≤ 0.05).

**Table (3): Comparison of the total cognitive achievement mean scores before, and after the intervention implementation between the two study groups.**

Items	Study group 1 N=160		Study group 2 N=160		Significance test between mean scores	Effect size (Cohen's d)
	No.	%	No.	%		
<b>Baseline cognitive achievement score =(40)</b>						
Low	158	98.8	157	98.1	t*=1.07 P=0.285	d=0.12
Moderate	2	1.3	3	1.9		
$\bar{x}$ (SD)	8.13(3.42)		8.56(3.67)			
<b>Post-test cognitive achievement score =(40)</b>						
Low	00	00	53	33.1	t*= 42.23 P ≤0.001	d=4.73
Moderate	9	5.6	107	66.9		
high	151	94.4	00	00		
$\bar{x}$ (SD)	33.45(2.14)		21.46(2.87)			

t\*: Independent t-test, d: Cohen's D (effect size of t test), P Significance \* Significant (p≤ 0.05).

**Table (4): Comparison of the mean scores of Self-Directed Learning (SRSSDL) before, and after the intervention implementation between the two study groups.**

Items	Study group 1 N=160	Study group 2 N=160	Significance test
	$\bar{x}$ (SD)	$\bar{x}$ (SD)	
<b>Learning awareness score=(60)</b>			
Before the intervention	43.06(3.81)	43.98(4.80)	t=1.90 P=0.058
Post- the intervention	52.29(4.30)	45.88(6.97)	t=9.90 P ≤0.001 d=1.10
<b>Learning strategies score=(60)</b>			
Before the intervention	44.76(4.45)	45.38(4.80)	t=1.19 P=0.233
Post- the intervention	49.67(3.68)	45.97(4.92)	t=7.61 P ≤0.001 d=0.85
<b>Learning activities score=(60)</b>			
Before the intervention	44.55(3.68)	45.29(4.48)	t=1.62 P=0.106
Post- the intervention	50.44(3.18)	45.80(4.54)	t=10.65 P ≤0.001 d=1.18
<b>Evaluation score=(60)</b>			
Before the intervention	44.03(5.23)	42.98(4.80)	t=1.85 P=0.064
Post- the intervention	50.66(4.62)	43.42(5.13)	t=13.26 P ≤0.001 d=1.48
<b>Inter-personal relationships score=(60)</b>			
Before the intervention	45.30(4.53)	44.48(4.14)	t= 1.68 P=0.093
Post- the intervention	51.67(3.01)	44.93(4.41)	t=15.93 P ≤0.001 d=1.78

t\*: Independent t-test, d: Cohen's D (effect size of t test), P Significance \* Significant (p≤ 0.05).

**Table (5): Comparison of the total mean Self-Directed Learning (SRSSDL) scores before, and after the intervention implementation between the two study groups.**

Items	Study group 1 N=160		Study group 2 N=160		Significance test between mean scores	Effect size (Cohen's d)
	No.	%	No.	%		
<b>Baseline Self-Directed Learning score =(300)</b>						
Low	5	3.1	3	1.9	t=1.165 P=0.245	d=0.13
Moderate	94	58.8	96	60		
High	61	38.1	61	38.1		
$\bar{x}$ (SD)	218.07(22.75)		221.08(23.52)			
<b>Post-test Self-Directed Learning score =(300)</b>						
Moderate	2	1.2	89	55.6	t=14.00 P ≤0.001	d=1.56
High	158	98.8	71	44.4		
$\bar{x}$ (SD)	254.52(11.74)		225.96(22.97)			

t\*: Independent t-test, d: Cohen's D (effect size of t test), P Significance

\* Significant ( $p \leq 0.05$ ).

**Table (6): Comparison of the total Student' Satisfaction and Self-Confidence in Learning scale (SSSCL) mean scores after the intervention implementation between the two study groups.**

Items	Study group 1 N=160		Study group 2 N=160		Significance test between mean scores	Effect size (Cohen's d)
	No.	%	No.	%		
<b>Total student' satisfaction score =(28)</b>						
Moderate	00	00	30	18.8	t=15.82 P ≤0.001	d=1.80
High	160	100	130	81.2		
$\bar{x}$ (SD)	24.60(1.20)		21.41(2.91)			
<b>Total self-confidence in learning score =(32)</b>						
Moderate	2	1.2	21	13.1	t= 21.92 P ≤0.001	d=2.40
High	158	98.8	139	86.9		
$\bar{x}$ (SD)	29.21(1.89)		24.0(2.41)			

t\*: Independent t-test, d: Cohen's D (effect size of t test), P Significance

\* Significant ( $p \leq 0.05$ ).

**Table (1):** Reveals homogeneity in all tested socio-demographic characteristics between the two study groups. Similarity-determining tests show no significant difference ( $P > 0.05$ ) between each group regarding all the studied baseline personal characteristics. The mean ages in group1 and group 2 were  $21.0 \pm 0.83$  and  $21.0 \pm 0.83$ , respectively. Nearly three-fourths of students in group1 (73.8%) and group 2 (81.9%) were in the third level. Concerning residence, slightly more than half of both study groups resided in urban areas. In terms of previous total GPA level, more than half of group1 (51.9%) and group 2 (54.4%) had a B+ level. A large percentage of the studied students didn't have previous information about mind mapping and flipped classroom strategies.

**Table (2):** Shows the mean scores of cognitive achievement domains in both groups regarding research methodology before and after the intervention implementation. At the baseline

assessment, lower mean scores were reported by both study groups regarding all the research methodology domains. After the intervention, these lower mean scores highly elevated in study group1 than in study group 2 as follows: basic concepts (group1:  $4.26 \pm 0.50$ , and group2:  $3.03 \pm 0.15$ ); importance of research (group1:  $4.64 \pm 0.48$ , and group 2:  $3.37 \pm 0.47$ ); research process (group1:  $6.61 \pm 0.59$ , and group2:  $3.74 \pm 0.82$ ); research designs (group 1:  $8.10 \pm 0.99$ , and group2:  $5.16 \pm 0.67$ ); data collection tools (group 1:  $6.94 \pm 1.23$ , and group 2:  $5.22 \pm 1.44$ ); and ethics of research (group1:  $2.90 \pm 0.97$ , and group2:  $2.53 \pm 0.50$ ).

Additionally, an independent t-test indicated homogeneity between the study groups before the intervention regarding all the cognitive achievement domains at ( $P > 0.05$ ). After the intervention, there were highly statistically significant differences between the two study groups regarding all the cognitive achievement domains at ( $P \leq 0.001$ ) with a

huge effect size of the intervention as follows: basic concepts ( $d=3.33$ ); importance of research ( $d=2.67$ ); research process ( $d=4.01$ ); research designs ( $d=3.47$ ); data collection tools ( $d=1.28$ ); and ethics of research ( $d=0.48$ ).

Comparison of the total mean cognitive achievement scores before and after the intervention between the two study groups is demonstrated in **Table (3)**: An independent t-test showed similarity between baseline cognitive achievement scores ( $P=0.285$ ). However, after the intervention, there was a significant statistical improvement in the total cognitive achievement mean score for group 1 ( $33.45\pm 2.14$ ) compared to the lower improvement in group 2 mean score ( $21.46\pm 2.87$ ), as demonstrated by the t-test ( $t = 42.32$ ,  $P \leq 0.001$ ) with a very high effect size ( $d = 4.73$ ).

**Table (4)**: Shows the mean scores of self-directed learning domains in both groups before and after the intervention implementation. At the baseline assessment, both study groups indicated a lower mean score regarding all the self-directed learning domains. After the intervention, this lower mean score increased in study group 1 more than study group 2 as follows: learning awareness (group 1:  $52.29\pm 4.30$ , and group 2:  $45.88\pm 6.97$ ); learning strategies (group 1:  $49.67\pm 3.68$ , and group 2:  $45.97\pm 4.92$ ); learning activities (group 1:  $50.44\pm 3.18$ , and group 2:  $45.80\pm 4.54$ ); evaluation (group 1:  $50.66\pm 4.62$ , and group 2:  $43.42\pm 5.13$ ); and interpersonal relationships (group 1:  $51.67\pm 3.01$ , and group 2:  $44.93\pm 4.41$ ).

In addition, the independent t-test indicated a similarity between the two study groups before the intervention regarding all the self-directed learning domains ( $P>0.05$ ). However, after the intervention, there were highly statistically significant differences between the two study groups regarding all the self-directed learning domains ( $P\leq 0.001$ ) with a highly elevated effect size of the intervention as follows: learning awareness ( $d=1.10$ ); learning strategies ( $d=0.85$ ); learning activities ( $d=1.18$ ); evaluation ( $d=1.48$ ); and interpersonal relationships ( $d=1.78$ ).

Comparison of the total mean self-directed learning scores before and after the intervention between the two study groups is shown in **Table (5)**: An independent t-test indicated no significant difference in baseline self-directed learning scores ( $P=0.245$ ). However, after the intervention, there was a statistically significant improvement in the total self-directed learning mean score for study group 1 ( $254.52\pm 11.74$ ) compared to the smaller changes in study group 2 mean score ( $225.96\pm 22.97$ ), as indicated by the t-test ( $t = 14$ ,  $P \leq 0.001$ ) with a very high effect size ( $d = 1.56$ ).

Comparison of the total mean students' satisfaction and self-confidence scores after the intervention between the two study groups is shown in **Table (6)**: There were significant statistical differences in the total mean students' satisfaction and self-confidence scores for study group 1 ( $24.60\pm 1.20$  and  $29.21\pm 1.89$ , respectively) compared to the lower mean scores in study group 2 ( $21.41\pm 2.91$  and  $24.0\pm 2.41$ , respectively), as indicated by the independent t-test at ( $P \leq 0.001$ ) with a very high effect size of the intervention ( $d=1.80$  and  $d=2.40$ ).

## Discussion

The mind map and flipped classroom are useful tools for organizing and summarizing complex information in a clear and concise manner. They can be used to study and memorize medical information, as well as to brainstorm ideas and plan projects (Nugroho et al., 2020). Therefore, the current study assessed the effectiveness of combining mind mapping and flipped classroom strategies on the cognitive achievement and practical (Self-Directed Learning) skills of nursing students regarding the research methodology subject. This study's aim aligns with Zheng, et al., (2020), who investigated the impact of a collaborative mind mapping strategy in a flipped classroom on learning achievement, self-efficacy, motivation, and students' acceptance. It also agrees with the study by Fan, et al., (2022) who explored the effects of a flipped classroom based on mind maps in the teaching of Obstetrics and Gynecology Nursing in higher vocational colleges.

In terms of the nursing students' socio-demographic characteristics, similarity determining tests showed non-significant differences in all tested characteristics between the two study groups. This similarity is required for any randomized trial to ensure that observed differences in study outcomes between the groups are due to the study intervention rather than confounding factors (Hohenschurz-Schmidt et al., 2023). This finding agrees with several studies (Chi et al., 2022; El-Sayed et al., 2023; Kaye, & Kim, 2023), which cited that the two study groups did not statistically differ from each other in terms of all studied demographic data ( $P> 0.05$ ).

The socio-demographic results showed that nursing students had a mean age of 21 years old in the two study groups. In terms of gender, the majority of nursing students in both groups were female. From the researchers' point of view, the nursing students in both groups were similar, and this similarity was crucial for a fair comparison. These findings supported El sayed et al. (2023), who reported that the students of both groups had an equal mean age. Similarly, Wu & Wu (2020) revealed that their



participants' age range was from 21-23 years, and the majority of participants were female.

In terms of nursing student' cognitive achievement, the results of this study indicate that the combination of flipped classroom and mind mapping learning strategies is better at improving students' cognitive achievement. The results of the cognitive achievement in the group 1 class show a pre-test mean score of 8.13 and a post-test mean score of 33.45, while the cognitive achievement of group 2 class shows a pre-test mean score of 8.56 and a post-test mean score of 21.46. It can be concluded that group 1, which uses a combination of flipped classroom and mind mapping learning methods, performs better than group 2, which uses the conventional blended learning method (flipped videos and traditional lectures).

According to the researchers, the novelty of combining the flipped classroom with mind mapping as a learning approach accounts for the significant improvement in student ' cognitive achievement. It also suggests that the information presented to them was engaging. Furthermore, combining out-of-classroom learning activities in the flipped classroom with mind mapping activities such as co-editing, assessing change history, and knowledge sharing encouraged collaborative engagement, construction, and information sharing.

This result agrees with **Zheng et al. (2020)**, who stated that the combination of collaborative mind mapping and the flipped classroom had the largest effect on students' learning achievement. This result is also supported by new evidence from **Sari, et al., (2023)**, who emphasized the importance of providing a combination of mind map strategy in the flipped classroom setting to foster students' learning outcomes, critical thinking skills, and motivation. Furthermore, two Asian studies by **Lin & Mubarak (2021) & Liu et al. (2022)** supported these results and concluded that the flipped classroom and mind map methods can effectively improve the learning achievements of their participants.

As regard self-directed learning skills, there was a statistically significant improvement in the total self-directed learning score in the group 1 class compared to the lower improvement in the group 2 class mean score after applying the intervention. According to the researchers, the collaboration of the flipped classroom and mind map can effectively improve the independent learning ability as the students had enough time to hear and watch flipped videos, and integrate the knowledge together to draw their own mind maps. This will invariably improve their independent learning abilities.

This finding agrees with the study of **Liu et al., (2022)**, who emphasized that using the combination of flipped classroom and mind map methods can effectively improve the autonomous learning ability of participants. It is also in harmony with various studies by **Fidan (2023)**, **Tejeswini et al. (2022)**, & **Diningrat & Ngussa (2022)**, who cited that the flipped classroom and mind maps can help students develop the ability of lifelong learning. They can also think independently, systematically, critically, and creatively.

The results of this study revealed that the combination of the flipped classroom and mind mapping learning strategies is better at increasing students' satisfaction and self-confidence than blended learning methods. Both groups following the intervention showed a highly statistically significant improvement, with the students in the study group 1 showing more improvement than those in the study group 2. From the researchers' point of views, this finding be due to the active participation of the students in the study group 1 in their learning process, where they were allowed to draw mind maps by hand, leading to improved thinking and increased self-confidence, ultimately resulting in higher student satisfaction.

This result is supported by **Fan et al. (2022)**, who revealed that the students in the experimental group, who implemented the combination of the flipped classroom based on mind maps in Obstetrics and Gynecology Nursing, showed higher satisfaction than the students in the other group. Additionally, **Elasrag & Elsabagh, (2020)** stated in their results that there were highly statistically significant differences regarding self-confidence between pre- and post -mind mapping application. Similarly, this finding was congruent with **Israel, (2019)**, who reported that the physician assistant students group who used mind maps showed higher scores of self-confidence than the standard note -taking group of students post -intervention of nine weeks. Similarly, **Huang (2020)** found that students are satisfied with collaborative mind mapping as a technique and have positive attitudes toward it.

### Conclusion:

The results of the study supported the hypotheses, as the combination of a mind mapping strategy and a flipped classroom significantly improved students' cognitive achievement and self-directed learning skills more than the blended method of a flipped classroom and traditional lecture. Additionally, students who participated in the collaborative method of mind mapping and flipped classroom were more satisfied and self-confident than the students who participated in the blended method.

**Recommendation:**

The study suggests that the collaboration of the flipped classroom and mind-mapping technique should be implemented as effective and acceptable teaching methods for nursing students' education. Additionally, nursing educators should adopt these collaborative teaching strategies in other nursing courses, and more optimization and evaluation are required.

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