ORIGINAL ARTICLE

Increase In Activity And Learning Outcomes In Pharmacy Mathematics With Jigsaw Cooperative Learning Model At Pharmacy Academy Of Dwi Farma

Renatalia Fika*,
*Pharmacy Academy of Dwi Farma Bukittinggi, Bukittinggi 26121, West Sumatera, Indonesia

E-mail: fikarenatalia@gmail.com
Tel: +62-752-625164
Fax: +62-752-625164

Introduction: In Pharmacy Diploma Program, mathematics is known as pharmaceutical mathematics. Due to the importance of pharmaceutical mathematics in practice, it is important to have a basic mathematical skill as a basis in calculations in pharmaceutical science. Therefore, it is necessary to create a lecturing condition that enables students more active in understanding the lessons. This research aims to describe the use of jigsaw cooperative learning model in the pharmacy mathematics lecture at the Pharmacy Academy of DWI Farma.

Method: The learning method an appropriate method for this research's purpose is Classroom Action Research with Jigsaw cooperative learning model. This research consists of 2 cycles with planning, execution, observation and reflection. In this research, researchers directly, become the research's perpetrators, seeks to improve the learning process with jigsaw cooperative learning model.

Result: The Minimum completion criteria for pharmacy mathematics lecture is 75. Average learning outcomes in the cycle I is 70.73, then increase in cycle II in 75,07. Based on Cycle II, The minimum completion criteria for this course has been achieved. The positive effects Jigsaw cooperative learning model include active, creative, confident, enthusiastic, and happy to work together in a group.

Conclusion: This research shows that increase in Activity and Learning Outcomes in Pharmacy Mathematics with Jigsaw cooperative learning model at Pharmacy Academy of DWI Farma can increase student learning activity in every cycle. Students become more active, creative, confident, enthusiastic, and happy to work together in a group.

Keywords: Pharmacy Mathematical, Jigsaw, cooperative learning model

زيادة فى النشاط ونتائج التعلم فى مجال الصيدليات مع نموذج التعلم التعاونى بانوراما (jigsaw) فى أكاديمية الصيدلة فى دوى فارما

المقدمة: فى برنامج دبلوم الصيدلة، الرياضيات معروفة بالرياضيات الصيدلانية. نظرا لأهمية الرياضيات الصيدلانية فى الممارسة العملية، فمن المهم التمتع بمهارة رياضية أساسية كأساس فى العمليات الحسابية فى العلوم الصيدلانية. لذلك، فمن الضرورى خلق حالة من المحاضرات التى تجعل الطلاب أكثر نشاطاً فى فهم الدروس. يهدف هذا البحث إلى وصف استخدام نموذج التعلم التعاونى بانوراما (jigsaw) فى محاضرة الرياضيات الصيدلانية فى أكاديمية الصيدلة فى دوى فارما.

المنهج: طريقة التعلم، طريقة مناسبة لهذا الغرض من البحث، هو البحث الإجرائى للفصول الدراسية مع نموذج التعلم التعاونى بانوراما .(jigsaw) يتكون هذا البحث من دورتين مع التخطيط والتنفيذ والمراقبة والإنعكاس. فى هذا البحث، أصبح الباحثون مباشرة مرتكبى البحث، ويسعى إلى تحسين عملية التعلم مع نموذج التعلم التعاونى بانوراما.(jigsaw)

النتائج: معايير الحد الأدنى لإنجاز محاضرات الرياضيات الصيدلانية هى ٧٥. متوسط نتائج التعلم فى الدورة الأولى هو ٧٠،٧٣، ثم زيادة فى الدورة الثانية إلى ٧٥،٠٧ . واستناداً إلى الدورة الثانية، تم تحقيق معايير الحد الأدنى لإنجاز هذه الدورة. الآثار الإيجابية لنموذج التعلم التعاونى بانوراما (jigsaw) تشمل نشاطاً، إبداعاً، ثقةً، حماسةً، وسعادةً للعمل معا فى مجموعة.

الخاتمة: ويبين هذا البحث أن الزيادة فى النشاط ونتائج التعلم فى الرياضيات الصيدلانية مع نموذج التعلم التعاونى بانوراما (jigsaw) فى أكاديمية الصيدلة فى دوى فارما يمكن أن تزيد من نشاط تعلم الطلاب فى كل دورة. يصبح الطلاب أكثر نشاطاً، إبداعاً، ثقةً، حماسةً، وسعادةً للعمل معا فى مجموعة.

الكلمات الدليلية: الرياضيات الصيدلانية، نموذج التعلم التعاونى بانوراما (jigsaw).

فارمیسی میں ریاضیات کو بہتر بنانے اور اچھے نتائج حاصل کرنے کےلئے جگ سا شراکتی پروگرام میں شرکت کرنا۔یہ تحقیق DWI FARMA فیکلٹی آف فارمیسی میں انجام دی گئي ہے

بیک گراونڈ: فارمیسی کے ڈپلومہ میں ریاضیات، اہم کردار ادا کرتی ہیں، عملی طور پر فارمیسی ریاضیات کی نہایت اہمیت کے پیش نظر یہ ضروری ہے کہ فارمیسی میں ریاضیات کو بنیادی طریقے سے پڑھایا جائے۔اس ھدف کے پیش نظرطلباء کو لکچر دینے کا موقع دیا جائے تا کہ وہ پڑھائی کے عمل میں دل لگا کر حصہ لے سکیں۔ اس تحقیق کا ھدف یہ ہے کہ جگ سا JIG SAW ماڈل کے ذریعے فارمیسی ریاضیات کی تعلیم کا جائزہ لیا گیا ہے۔

روش : اس تحقیق کے لئے پڑھائي کی مناسب روش فعال تحقیقاتی روش اپنائي گئي اور اس کے لئے جگ سا ماڈل استعمال کیا گیا۔ اس تحقیق کے دو مرحلے تھے ایک پروگرامنگ کا اور دوسرا عمل درامد اور رد عمل کا۔اس تحقیق میں محققیں نے خود اپنی تحقیقات پر عمل کیا ہے اور وہ جگ سا ماڈل کے ذریعے بہتر تعلیمی روش ڈھونڈ رہے ہیں۔

نتیجے: فارمیسی ریاضیات میں پاس ہونے کےلئے کم سے کم نمبر پچہتر ہیں۔پہلے سیمسٹر میں یہ نمبر ستر اعشاریہ تہتر ہیں، دوسرے مرحلے میں یہ نمبر پچہتر تک پہنچ جاتے ہیں۔ دوسرے مرحلے کے نتائج کے مطابق کم سے کم نمبروں کا معیار حاصل ہوا ہے۔ جگ سا ماڈل نے جس میں سب طلبا مل کر تعلیم حاصل کرتے ہیں، وہ فعال رہنے، تخلیقی صلاحیتوں، خود اعتمادی، شوق وجذبے اور تعلمی روش سے اطمینا جیسے امور پر مثبت اثرات مرتب کئے ہیں۔

سفارش :اس تحقیق سے پتہ چلا ہے کہ جگ سا ماڈل طلبا کی تعلیمی صلاحیتوں کو بہتر بناتا ہے لذا ڈی ڈبلیو آئي فارما میں اس پر بھرپور طرح سے عمل کیا جائے۔

کلیدی الفاظ: فارمیسی ریاضیات،جگ سا، تعلیمی ماڈل ۔

افزایش کارایی و دست آوردهای آموزشی در ریاضیات دارویی با استفاده از الگوی یادگیری مشارکتی JIGSAW در دانشکده داروسازی DWI FARMA

مقدمه: در برنامه دیپلم داروسازی، ریاضیات به عنوان ریاضیات دارویی شناخته شده است. به دلیل اهمیت ریاضیات دارویی در عمل، مهم است که یک مهارت اساسی ریاضی را به عنوان پایه در محاسبات در علم دارویی داشته باشیم. بنابراین، ایجاد شرایط و محیط سخنرانی برای دانش آموزان تا بتوانند در امر یادگیری فعال تر عمل کنند، ضروری است. هدف تحقیق حاضر تشریح کاربرد الگوی یادگیری مشارکتی JIGSAWدر ریاضیات دارویی در دانشکده داروسازی DWI FARMA می باشد .

روش: روش یادگیری مناسب برای هدف مطالعه حاضر، روش کلاس فعال پژوهشی با الگوی یادگیری مشارکتی JIGSAW می باشد. تحقیق حاضر دارای ۲ دوره با برنامه ریزی، اجرا، مشاهده و بازتاب می باشد. در این تحقیق، محققان به طور مستقیم به عاملان تحقیق تبدیل می شوند، و به دنبال بهبود فرایند یادگیری با مدل یادگیری مشارکتی JIGSAW هستند .

نتایج: حداقل نمره برای تکمیل دوره سخنرانی ریاضیات دارویی ۷۵ می باشد. میانگین نتایج یادگیری در دوره اول ۷۰،۷۳ است، و در دوره دوم به ۷۵ افزایش می یابد. بر اساس نتایج دوره دوم، حداقل معیار تکمیل دوره به دست آمده است. تاثیر مثبت الگوی یادگیری مشارکتی JIGSAW شامل فعال بودن، خلاقیت، اعتماد به نفس، شور و شوق و رضایتمندی برای همکاری در گروه است.

نتیجه گیری: تحقیق حاضر نشان داد که کارایی و دست آوردهای آموزشی در ریاضیات دارویی با استفاده از الگوی یادگیری مشارکتی JIGSAW می تواند کارایی یادگیری دانش آموزان را در هر دوره در دانشکده داروسازی DWI FARMA افزایش دهد. دانش آموزان فعال تر، خلاق تر، با اعتماد به نفس بیشتر، مشتاق تر و راضی از کار گروهی هستند .

کلید واژه ها: ریاضیات دارویی، Jigsaw، الگوی آموزشی مشارکتی

INTRODUCTION

In Pharmacy Diploma Program, mathematics is better known as pharmaceutical mathematics (1). Pharmaceutical mathematics is the study of basic mathematical calculations which is used in pharmaceutical calculations course (2). Futhermore, pharmaceutical mathematics is a field of study or science that applies the basic principles of mathematics that aims to prepare skills which will be used in calculating pharmaceutical supplies effectively (3). In studying pharmaceutical mathematics, basic mathematical skills are essential (4). Without strong mathematical basic ability, the students will have difficulty in calculating the standard of prevalent and maximum dose of a drug (5,6).

Pharmaceutical mathematics is a supporting and also applied as one of prerequisite course when students want to take pharmaceutical practice course, which is a course where students practice in a pharmaceutical laboratory how a medicine's was made and work. This course starts when student study how a medicine's journal is made by examining the prescription's completeness, calculating the dose (start from the prevalent to the maximum amount), followed by weighing the drug's material and create how the drug work and what etiquette which the drug has (7). Afterwards, the drug is formulated and handed over to a laboratory supervisor who acts as a patient at the time the drug is submitted. Due to the importance of pharmaceutical mathematics in the pharmaceutical practice course, it requires students to have strong basic mathematical skills as a basis in calculations in pharmaceutical science (8).

But in reality during the lecture, there are still a lot of students who have poor basic math skills. Differences in students' academic ability are a very important aspect which needs to be noticed by the lecturer during the lecturing process (9). During the lecturing process, there is a sense of shame to ask and discuss which is owned by students whose poor basic mathematical skills (10). They become less involved in the process of solving problems in the pharmaceutical mathematics course. As a result, they do not understand the material which was presented and have difficulties in the pharmaceutical practice course (11). Students' involvement in lecturing process is low, proven by there are some students who have low competitive feeling and low sense of togetherness in lecturing process. The students' participation in the lecturing activity is very individual, which can be seen from the reluctance that they show when the lecturer create group discussion. They averse to discuss with their teammate. The low participation is also caused by the lack of students' confidence in expressing their opinions or answering the questions that lecturer give to them. Some students prefer to wait for answers from their peers instead of working on their own answers (9).

To overcome the condition which is not conducive to the lecturing process and to foster students' motivation to be active in the course, the lecturer has given continuous exercises and directly evaluate the problems together with the students, so that students know the extent of their ability related to particular material immediately. In addition, it has also been attempted by the lecturer to encourage students to solve the problem in front of the class. For lecturing guides, the college has lent some reference books that must be owned by students to make them more understand the course material and easier to answer the problem in HER exams (9, 12). In lecturing process, lecturer try to create a group discussion, but as the time goes by, this way becomes less effective. The failure is caused by students are very individual in the learning process, some students tend to be selfish and hard to share their knowledge in group discussions and there are still students whose low confidence in expressing opinions in group discussions (13, 14).

The implemented efforts have not given a fundamental change and better result. Students still tend to be selfish and hard to share their knowledge in the discussion, they tend to be passive and less participate in lecturing process, lack of competitiveness in lectures, lack of response to ask questions and answer questions. This can be seen from the activities of students who just record, hear, and a little question and discussion (15). Based on the facts above, it is deemed necessary to take action which can improve the activity and learning outcomes for students. One of the actions that can be done is by creating a cooperative learning method that can enhance the students' involvement through discussion in the learning process. The characteristics of cooperative learning are learning model which is not centered to the teacher. The basic principle of cooperative learning is students form small groups and teach each other to achieve common goals, so that students will have a good ability at teaching students who are less clever without feeling disadvantaged (16,17). Through this learning method, the students together with their group learn in mutual assistance, each member of the group help each other. Individual failure is group failure and individual success is group success (18).

In cooperative learning, students are not only required to achieve success individually or try to beat their colleagues, but also required to work together to achieve mutual results, social aspects are very prominent and students are required to be responsible for their group's success. Cooperative learning that will be used in this research is Jigsaw type. The jigsaw cooperative learning model is a model of learning that can stimulate students to think actively and creatively in the learning process. This model can develop the intellectual and emotional ability and all the potential that exist in the students. By applying the Jigsaw cooperative learning model, students not only learn the material provided, but they also learn how to give and teach the material to the members of the group (19).

This research aims to describe the implementation of jigsaw type cooperative learning model in order to increase activity and learning outcomes in the pharmacy mathematics lecture at the Pharmacy Academy of DWI Farma.

METHODS

The type of research which is conducted is Classroom Action Research (Classroom Action Research) with cycle model. While the design refers to the Kemmis & McRaggart, model consists of: (1) planning; (2) action; (3) observation; And (4) reflection (20,21). In this research, researchers directly, become the research's perpetrators, seeks to improve the

learning process with jigsaw cooperative learning model. This research is conducted in two cycles. Reflection stage is done to evaluate the weakness in each cycle, so that there will be improvement in the next cycle. If the criteria of action has been reached, but the learning outcomes have not been reached at the mean of 75, then the researcher goes into action II. But if the both of criteria of action have not been achieved, then the researcher repeats action I and fixes the existing weakness. The steps which will be undertaken in this action research include the planning stage and the implementation stage of the research activity (22). Details of these steps can be explained as follows.

1. Planning Stage,

This planning stage includes activities:

a. Early reflection

At this stage activities make preliminary test, determine data sources, perform preliminary tests, and assign groups and choose 4 students to be interviewed(23).

b. Establish and formulate action draft.

At this stage the activities undertaken are determining the learning objectives, prepare the problem-solving, learning activities with jigsaw cooperative learning model, prepare teaching materials, LKS I and LKS II for group discussion, observation sheet, questionnaire and format Interviews that observers will use during the course of action (24,25).

2. Implementation Phase Research Activities

Activities during this stage is conducting activities based on planning stage. Observation of the implementation was evaluated by using an observation sheet. The result of observation will be analyzed as the evaluation of the research. The weakness or leverage found in cycle one will be fixed in cycle two and beyond. The indicator of success in each cycle of learning outcomes has a mean of 75. The jigsaw cooperative learning model will be implemented in several stages as follows.

1. Preparation

a. Material

b. The material in each chapter is divided into several sections, depends on the number of members in each group, the number of material concepts that students want to achieve or learn in cooperative groups in both groups (origin and expert groups). The topic can be written on the board and ask for the students what they know regarding to the topic. This activity aims to recall knowledge that has connection with the topic which will be studied. After that, the material presented in outline to students (26,27).

c. Establish cooperative groups in the class

For Jigsaw model, the most effective group consists of 4-5 people. This group should consist students who are high, moderate and low based on their ability as well as by gender as follows. Rank students based on their ability and determine the number of groups, Divide students into groups. The division of students in the group needs to be balanced, so that each group consists of students with a balanced level of ability (28).

c. Determine the initial score, based on an individual student's average score on the previous quiz(29).

d. Preparing students for work cooperatively

Before the learning process begin, students are given the opportunity to get to know each other more about their group members, prepare questions about the quiz to be done individually(30).

e. Determine allocations and time-sharing tailored to the learning stage.

f. Group award

After the quiz is completed, the lecturer will calculate the students' score both individually and Grouply. Scores obtained by students are used to determine the value of individual development and to determine group scores (31). The group score is calculated based on the total development score of all group members divided by the number of group members, such as the following formula.

$$Nk = \frac{Total\ all\ members'\ developmental\ score}{number\ of\ team\ member}$$

Nk = Group developmental value

There is some compliment that can be given to students for their achievement, such as math stars, super best, and math genius and so on. This award is given to groups that can achieve the criteria that have been set together. To determine the level of group awards can be used level of group awards: As we can see in the table above, for the group which get 15 points, the team will be classified a good team. In the group which get 20 points, the team will be classified as the great team. Meanwhile, the 25-points team will be appreciated as the super team (32).

Classroom Learning Plans

The description of the implementation plan of problem-solving learning in pharmaceutical mathematics lectures with jigsaw cooperative learning model can be seen in table 2.

Table 1. Individual Learning Scoring Criteria

Individual score	Development Score
More than 10 points below initial score	5 points
1 - 10 point below initial score	10 points
1 - 10 points above the initial score	20 points
More than 10 points above the initial score	30 points
Perfect score (not based on initial score)	30 points

Table 2. Implementation plan for problem-solving learning on pharmaceutical mathematics lectures with Jigsaw cooperative learning model

Stages of Teaching	object	Activity	
		Lecturer	Student
A. Pre-instructional (Early stage)	Enhance motivation mastery/ understanding of learning materials	- Delivering the material outline, ask some questions - Explains the rules of the game in Jigsaw cooperative learning model, group duties and responsibilities	- Responding to the lecturer's explanation - Asking questions for any less Understandable material. - Responding to the lecturer's explanation - Provide answers to questions asked by the lecturer
B. Instructional Core Stage	- Enable group work - Measure / assess the mastery of the material to the responsibilities given -Knowing the mastery of the material during group work		
1. Step 1		- Distribute LKS to original group so that each member in the original group receives 1 LKS with 1 sub subject - Ask students to study the material in the LKS and the group leader appoints each student to master a material that becomes his expertise	- - - Receive LKS part, every student gets 1 LKS with 1 sub subject The group team learns the material to which he or she is responsible
Step 2		- Divide students who have the same LKS into cooperative learning groups (expert groups).	- Form a group of experts
Step 3		- Ask students to work together to complete the tasks that exist in each LKS.	- Discuss in order to understand the material.
Step 4		- The students back to the original group	- Each member of the expert groups returns to the original group to discuss / explain the subject sub-section.
Step 5		- Ask students to share the important information that they have learned. - Controlling students' understanding by asking questions - Telling all members in their group to ask each other questions	- Questions and answers among group members about the matter of quadratic equations - All group members try to explain to members of the group who do not understand
The final stage			
Step 6		Provides quiz / test questions	- Answering quiz / test questions
Step 7		- Give appreciation to the best group	- The winning group received the award

Table 3. Observation Result of Student Activity of Origin Group in Cycle I and Cycle II

No	Student activity	Cycle I				Cycle II			
		Meeting ... Figures and%			Average (%)	Meeting ... Figures and%			Average (%)
		1	2	3		1	2	3	
1	Active (in collaboration) in group discussions	(26) 62%	(27) 64%	(29) 69%	65%	(31) 74%	(33) 79%	(36) 86%	79,7%
2	present expert material bravely	(12) 29%	(15) 36%	(19) 45%	36,7%	(21) 50%	(27) 64%	(34) 81%	65%
3	Pay attention to friends who are presenting expert material	(14) 33%	(17) 40%	(20) 48%	40,3%	(25) 60%	(30) 71%	(36) 86%	72,3%
4	Help friends who have difficulty in learning	(18) 43%	(18) 43%	(20) 48%	44,7%	(24) 57%	(28) 67%	(33) 79%	67,7%
5	Dare to ask questions	(11) 26%	(14) 33%	(18) 43%	34%	(22) 52%	(27) 64%	(32) 76%	64%
6	Dare to answer the questions of other lecturers / students	(15) 36%	(16) 38%	(20) 48%	40,7%	(26) 62%	(30) 71%	(34) 81%	71,3%
7	Conducting activities that are not related to lectures	(19) 45%	(17) 40%	(17) 40%	41,7%	(14) 33%	(12) 29%	(8) 19%	27%
Number of students present		42				42			

RESULTS

Aspects that are observed in each student during the research activity is students' activity during the lecturing process.

Note for table 3:

Meeting.... its meaning face to face in the week.....

Ex:

1st meeting on the 1st cycle means student activity observation in origin group in the 1st week when Cycle I and Cycle II was conducted.

2nd meeting on the 1st cycle means student activity observation in origin group in the 2nd week when Cycle I and Cycle II was conducted.

3rd meeting on the 1st cycle means student activity observation in origin group in the 3rd week when Cycle I and Cycle II was conducted.

The result of observation on student learning activity of Origin group during cycle I and cycle II in Table 3 shown in the form of bar chart in Figure 1 below.

Note for table 4:

Meeting to.... its meaning face to face in the week.....

Ex:

1st meeting on the 1st cycle means student activity observation in expert group in in the 1st week when Cycle I and Cycle II was conducted.

2nd meeting on the 1st cycle means student activity observation in expert group in in the 2nd week when Cycle I and Cycle II was conducted.

3rd meeting on the 1st cycle means student activity observation in expert group in in the 3rd week when Cycle I and Cycle II was conducted.

The result of observation on student learning activity of expert group during cycle I and cycle II in Table 4 shown in the form of bar chart in Figure 2 below.

Based on table 3 and table 4, it can be seen that there is an improvement in student activity in the group of origin and group of experts during cycle I and cycle II in the lecturing process.

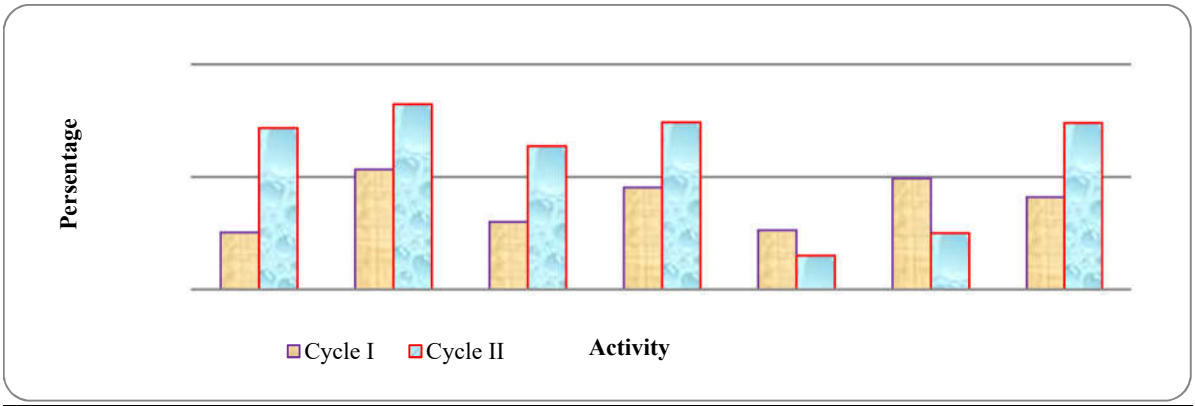

Figure 1. Diagram of Learning Activity of Origin Group in Cycle I and Cycle II

Table 4. Observation Results of Student Activity of Expert Group In Cycle I and Cycle II

No	Student activity	Cycle I			Average (%)	Cycle II			Average (%)
		Meeting .... Figures and%				Meeting ... Figures and%			
		1	2	3		1	2	3	
1	Appreciate / accept friends opinion	(9) 21%	(10) 24%	(13) 31%	25,3%	(25) 60%	(31) 74%	(34) 81%	71,7%
2	Interact with expert group friends	(20) 48%	(23) 55%	(24) 57%	53,3%	(31) 74%	(35) 83%	(38) 90%	82,3%
3	Giving an opportunity to friends who want to express their opinions	(9) 21%	(13) 31%	(16) 38%	30%	(21) 50%	(26) 62%	(33) 79%	63,7%
4	Dare to express opinions in group discussions	(19) 45%	(18) 43%	(20) 48%	45,3%	(27) 64%	(32) 76%	(35) 83%	74,3%
5	Do not give any answer or explanation for friend's question	(12) 29%	(11) 26%	(10) 24%	26,3%	(9) 21%	(6) 14%	(4) 10%	15%
6	Be indifferent and self-taught	(22) 52%	(20) 48%	(20) 48%	49,3%	(16) 38%	(11) 26%	(5) 12%	25%
7	Dare to ask friends	(17) 40%	(17) 40%	(18) 43%	41%	(25) 60%	(31) 74%	(37) 88%	74%
Number of students present		42				42			

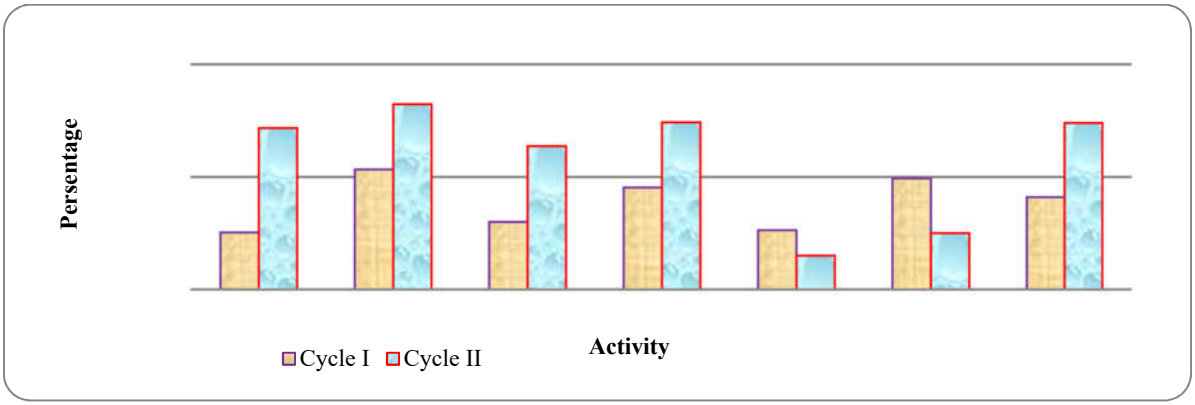

Figure 2. Diagram of Learning Activity of Expert Group in Cycle I and Cycle II

Table 5. Learning Outcomes in Cycle I and Cycle II

	Cycle I			Cycle II		
	The meeting			The meeting		
	1	2	3	1	2	3
Average value	68,60	71,41	72,18	74,15	75,04	76,02
Average		70,75			75,07	

While the student learning outcomes in the cycle I and cycle II can be seen in table 7, which shows an increase in mean values between the cycle I and cycle II.

DISCUSSION

1. Learning Activity

From the data in Table 3, the bar chart in Figure 1 can be explained as follows: Active student activity (working together) in group discussions has improved from the cycle I to cycle II. This increase of students activeness due to the increase of students' interest in learning, since they consider some different from previous learning. In this lecturing process, lectures emphasize that the success of a student depends on other friends, it is very important to grow the spirit of course in learning (35,36). The students' braveness to try to present the material has increased from the cycle I to cycle II. From the observation results, the increase was caused by lecturers are always trying to encourage the students to try to present the material in front of the class (34). The attention that students give to the friend who is presenting the material has also increased from the cycle I to cycle II. This increase of students' attention due to the increase of students' interest in learning. At the moment their friend presented the expert material in front of the class, they feel a new atmosphere and they were encouraged in conducting discussions among fellow friends (37). Students' activity to help friends who are facing learning difficulties come through a significant increase from the cycle I to cycle II. This increase is caused by some students feel satisfied when successfully helping a friend who has difficulty in learning (38). Students' braveness to ask questions, improve significantly from the cycle I to cycle II. This increase is caused by students feel more no burden to ask with friends and lecturers during discussion which was held in the Jigsaw cooperative learning model (39,40). Students' braveness to answer either lecturer's or their friends' questions increase from the cycle I to cycle II. This increase due to the discussion make students have a better understanding of the material (41). The distraction which happened during the lecturing process also decline until the end of cycle II. When lecturing process, lecturers always try to pay attention to the students who sit behind the class. Special attention while giving an understanding is given to students who are accustomed to making a commotion during the lecturing process. During the discussions, lecturers go around the whole class occasionally, so that this will reduce the opportunity for students to distract their friends during the discussion.

From the data in Table 4, the bar chart in Figure 2 can be explained as follows: During cycle I to cycle II, it can be shown that students have a better appreciation / can more accept the opinions of friends during the discussions. Students' interaction with their expert group friends improve from the cycle I to cycle II. From the results of observations during the learning process, this increased interaction occurred because lecturers always try to dig up students' braveness to try to present the material in front of the class. During cycle I to cycle II, it can be shown that students more give opportunity to their friend to give an opinion. It was happening because lecturers always try to motivate students to express their opinion during the discussion. The lecturers

Changes in the form of increase or decrease for each original group's meeting are shown in the bar chart in Figure 3 below.

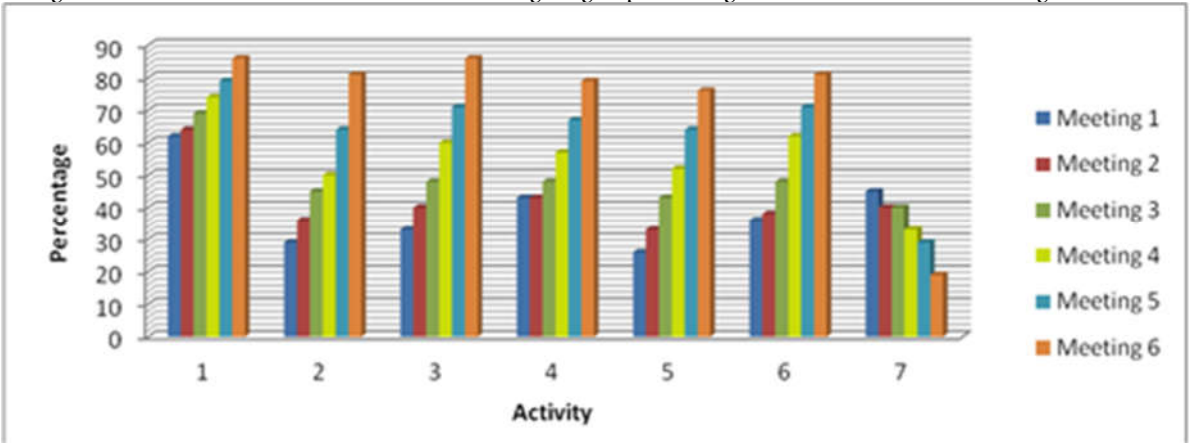

Figure 3. Student Activity Student Activity Bar on Student Group

Changes in the form of increase or decrease for each expert group's meeting are shown in the bar chart in Figure 4 below.

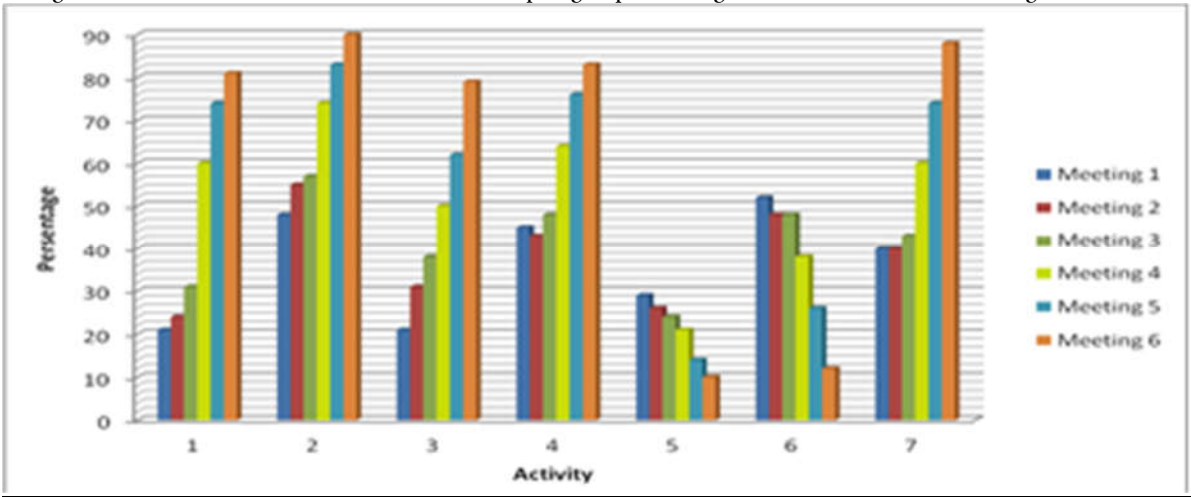

Figure 4. Student Activity Student Activity Bar Chart of Experts Group

Changes in the form of increase or decrease for each origin group's meeting are shown in the bar chart in Figure 5 below.

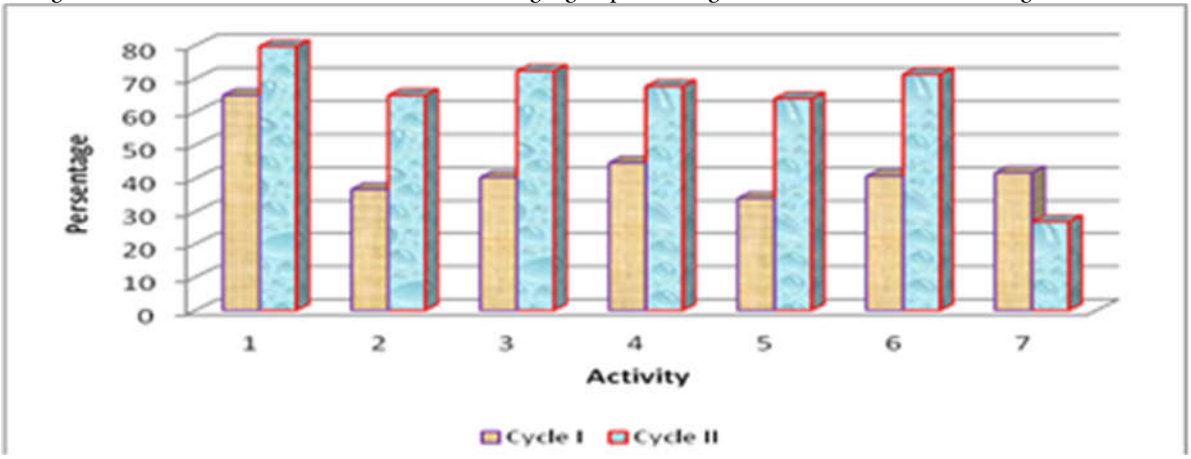

Figure 5. Student Learning Activity for Origin group in each cycle Diagram

give the students understanding that anyone can have different opinions. As a result, different opinions will create an idea of the problem. Students' braveness to express opinions in the group improve into a significant increase from the cycle I to cycle II (41,42).

The indicator of student who does not answer their friend's question decreased until the end of cycle II. It was triggered because lecturers always try to motivate students to always ask about the material which has not been understood even though it has been explained. The lecturer will not consider the student who asks as a stupid student. Contrastly, lecturers will give praise to students who have the braveness to ask. Lecturers will be happy if there are students who brave to ask. The indicator of students is self-indulgent and self-learning has decreased significantly from the cycle I to cycle II. The students argue that have a discussion with college friend give them satisfaction in the learning process when it can help friends who have difficulty in learning. Students' activities dare to ask friends to increase from the cycle I to cycle II (43). The researcher, as the implementing teacher and observer, agreed to stop the research action until this cycle II. This is because all the success indicators which have been set for each activity indicator have been met.

2. Student Learning Results

From Table 5 shows that there is an increase in the average learning outcomes score from the cycle I to cycle II. This increase is certainly due to some improvements, as an implementation of the reflections made into cycle I and cycle II, in a learning process which was made by the lecturer. Finally, the researcher and observer agree to fulfill the research implementation until cycle II. From this improvement, it can be concluded that Problem Solving at Pharmaceutical Mathematics Lecture with Jigsaw Cooperative Model Learning at Pharmacy Academy of DWI Farma can Increase activity and result of student learning in every cycle (35, 44).

Changes in the form of increase or decrease for each activity indicator in expert group are shown in the bar chart in Figure 6 below

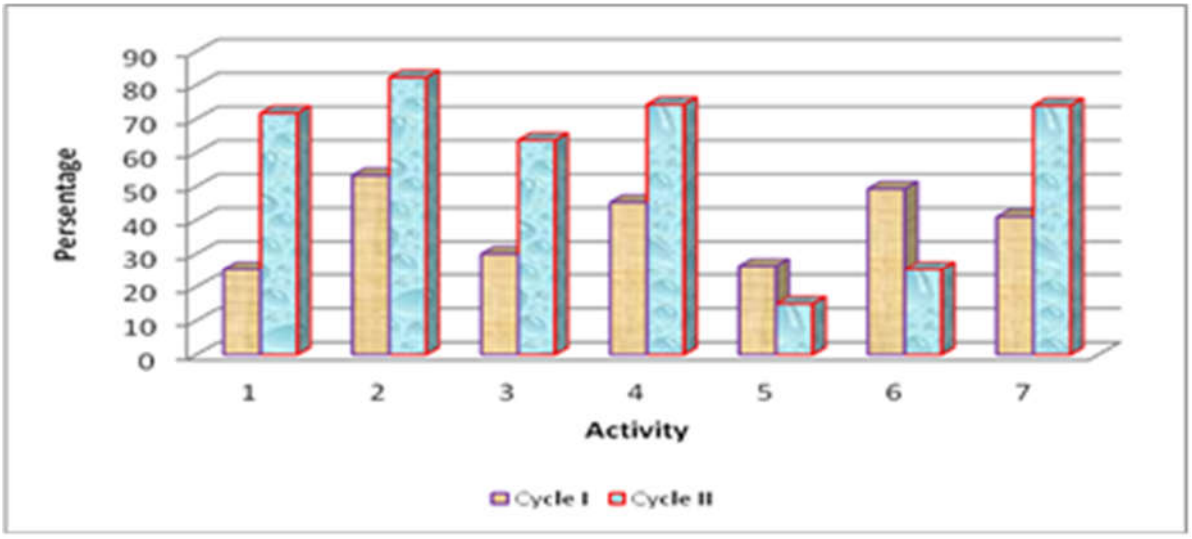

Figure 6. Student Learning Activity for Origin group in each cycle Diagram

Table 6. Percentage recapitulation of Student Learning Activity in Group of Origin

RECAPITULATION TABLE FOR STUDENT LEARNING ACTIVITY'S ORIGIN GROUP (%)							
Meeting	ACTIVITY						
	1	2	3	4	5	6	7
1	62%	29%	33%	43%	26%	36%	45%
2	64%	36%	40%	43%	33%	38%	40%
3	69%	45%	48%	48%	43%	48%	40%
4	74%	50%	60%	57%	52%	62%	33%
5	79%	64%	71%	67%	64%	71%	29%
6	86%	81%	86%	79%	76%	81%	19%

he jigsaw cooperative learning model is designed to enhance students' responsibility, whether in materials or tasks which become their part or not. Students not only learn the material provided, but they must also be ready to give and teach the material to other group members (28,45). Thus, it can arise interdependent attitudes and behavior and provide opportunities for students to help each other in the learning process. This condition can encourage students to study together and be responsible to achieve common goals. Studying together opens opportunities for students to practice courage to discuss and have responsibility in lecturing process. Students are expected to discuss to equate the knowledge they possess and overcome the knowledge gaps between each other. The presence of heterogeneous group discussions enables students' differences to be overcome because students are helping each other, amongst clever students with less-clever students (46).

CONCLUSION

Research on cooperative learning process with Jigsaw type found the following things:

a. Students are able to implement cooperative skills well. The Jigsaw type cooperative learning model is implemented in accordance with the steps in the Jigsaw type cooperative implementation, i.e. the formation of the originating group, the presentation of the material by the teacher, the presentation of the task by the teacher, the formation of expert groups, expert group discussions, the origin group discussion, the tests / quiz, group award.

b. Student acceptance of Jigsaw type cooperative learning model is very good, it can be seen that every student is pleased, enthusiastic, and can work together well. Students are more active, sharing each other ideas. Because the learning atmosphere is more conducive, new and appreciation given to the group, each group are competent to achieve good achievement. The presence of students in every learning is also always complete.

c. Jigsaw type cooperative learning accentuates group collaboration to study or comprehend a different material. Learning with cooperative Jigsaw type make the students have the freedom to ask a group of friends because generally students are reluctant to ask the teacher as a mentor if he

Table 7. Percentage recapitulation of Student Learning Activity in Expert Group

RECAPITULATION TABLE FOR STUDENT LEARNING ACTIVITY'S EXPERT GROUP (%)							
Meeting	ACTIVITY						
	1	2	3	4	5	6	7
1	21%	48%	21%	45%	29%	52%	40%
2	24%	55%	31%	43%	26%	48%	40%
3	31%	57%	38%	48%	24%	48%	43%
4	60%	74%	50%	64%	21%	38%	60%
5	74%	83%	62%	76%	14%	26%	74%
6	81%	90%	79%	83%	10%	12%	88%

Table 8. Percentage of Student Activities In Group of Origin Per cycle.

RECAPITULATION TABLE FOR STUDENT LEARNING ACTIVITY'S ORIGIN GROUP (%)							
CYCLE	ACTIVITY						
	1	2	3	4	5	6	7
I	65%	36,7%	40,3%	44,7%	34%	40,7%	41%
II	79,7%	65%	72,3%	67,7%	64%	71,3%	27%

Table 9. Percentage of Student Activity In Cycle Expert Group.

RECAPITULATION TABLE FOR STUDENT LEARNING ACTIVITY'S IN EXPERT GROUP (%)							
CYCLE	ACTIVITY						
	1	2	3	4	5	6	7
I	25,3%	53,3%	30%	45,3%	26,3%	49,3%	41%
II	71,7%	82,3%	63,7%	74,3%	15%	25,3%	74%

Table 10. Average Scores of Learning Outcomes		
LEARNING OUTCOMES		
CYCLE	I	II
AVERAGE RATE CYCLE	70,75	75,07

d. encounters difficulties in understanding a problem. The research shows that increase in Activity and Learning Outcomes in Pharmacy Mathematics with Jigsaw cooperative learning model at Pharmacy Academy of DWI Farma can increase student learning activity in every cycle. Students become more active, creative, confident, enthusiastic, and happy to work together in a group. The average value of student learning outcomes in the cycle I = 70, 73, and there's increasing in cycle II to 75, 07.

ACKNOWLEDGEMENT

The publication of this scientific article can not be separated from the support and assistance obtained from various parties. Therefore, the authors would like to express the gratitude and say thank you for the great cooperation from colleagues of DWI Farma Pharmacy lecturers. The authors also thank to the entire Civitas of DWI Farma Pharmaceutical Academy who has helped by this research can be implemented and also to the Future Reviewer of Medical Education Journal (FMEJ).

REFERENCES

1. Basak SC, Sathyanarayana D. Pharmacy education in India. Am J Pharmaceutic Educ 2010; 74: 68.
2. Ansel HC, Popovich NG, Allen L V. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems. J Chem Inf Model 2011; 9: 160.
3. Sinko PJ. Martin's physical pharmacy and pharmaceutical sciences. Physical chemical and biopharmaceutical principles in the pharmaceutical sciences; 2011: 182-96.
4. Erbas AK, Kertil M, Çetinkaya B, Çakiroglu E, Alacaci C, Bas S. Mathematical modeling in mathematics education: Basic concepts and approaches. Educ Sci Theory Pract 2014; 14(4): 1621-7.
5. Bagnasco A, Galaverna L, Aleo G, Grugnetti AM, Rosa F, Sasso L. Mathematical calculation skills required for drug administration in undergraduate nursing students to ensure patient safety: A descriptive study. Drug calculation skills in nursing students. Nurse Educ Pract 2016; 16(1): 33-9.
6. Eastwood K, Boyle M, Kim V, Stam N, Williams B. Mathematical ability of first year undergraduate paramedic students-A before and after study. Nurse Educ Today 2015; 35(11): 1125-9.
7. Mesquita AR, Souza WM, Boaventura TC, Barros IMC, Antoniolli AR, Silva WB, et al. The effect of active learning methodologies on the teaching of pharmaceutical care in a Brazilian pharmacy faculty. PLoS One 2015; 10(5): e0123141.
8. Chereson RS, Bilger R, Mohr S, Wuller C. Design of a pharmaceutical care laboratory: A survey of practitioners. Am J Pharm Educ 2005; 69(1): 19-24.
9. Fernández-Santander A. Cooperative learning combined with short periods of lecturing: A good alternative in teaching biochemistry. Biochem Mol Biol Educ 2008; 36(1): 34-8.
10. Kassab S, Hassan N, Abu-Hijleh M, Sequeira R. Lecturing skills as predictors of tutoring skills in a problem-based medical curriculum. Adv Med Educ Pract 2016; 7: 1-6.
11. Bourne DWA, Davison AM. A self-paced course in pharmaceutical mathematics using web-based databases. Am J Pharm Educ 2006; 70(5): 116.
12. Croft T, Duah F, Loch B. "I'm worried about the correctness': undergraduate students as producers of screencasts of mathematical explanations for their peers - lecturer and student perceptions. Int J Math Educ Sci Technol 2013; 44(7): 1045-55.
13. Dornan T, Boshuizen H, King N, Scherpbier A. Experience-based learning: A model linking the processes and outcomes of medical students' workplace learning. Med Educ 2007; 41(1): 84-91.
14. Wood WB, Tanner KD. The role of the lecturer as tutor: Doing what effective tutors do in a large lecture class. CBE Life Sci Educ 2012; 11(1): 3-9.
15. Bos N, Groeneveld C, van Bruggen J, Brand-Gruwel S. The use of recorded lectures in education and the impact on lecture attendance and exam performance. Br J Educ Technol 2016; 47(5): 906-17.
16. Taylor DCM, Hamdy H. Adult learning theories: Implications for learning and teaching in medical education: AMEE Guide No. 83. Med Teach 2013; 35(11): e1561-72.
17. Slavin RE. Cooperative learning in schools. In: International Encyclopedia of the Social and Behavioral Sciences. [cited 2016]. Available from: URL; http://linkinghub.elsevier.com/retrieve/pii/B9780080970868920282
18. Rodríguez Montequín V, Mesa Fernández JM, Balsera JV, García Nieto A. Using MBTI for the success assessment of engineering teams in project-based learning. Int J Technol Des Educ 2013; 23(4): 1127-46.
19. Berger R, Hänze M. Impact of expert teaching quality on novice academic performance in the Jigsaw Cooperative Learning Method. Int J Sci Educ 2015; 37(2): 294-320.
20. Kemmis S, McTaggart R, Nixon R. The action research planner. Doing critical participatory action research. USA: Springer; 2014: 154.
21. Cain T. Teachers' classroom-based action research. Int J Res Method Educ 2011; 34(1): 3-16.
22. Norton LS. Action Research in Teaching and Learning. A practical guide to conducting pedagogical research in universities. [cited 2009]. Available from: URL; http://www.amazon.com/Action-Research-Teaching-LearningUniversities/dp/0415468469
23. Xie T, Zheng Q, Zhang W. A behavioral sequence analyzing framework for grouping students in an e-learning system. Knowledge-Based Syst 2016; 111: 36-50.
24. Doymus K. Teaching chemical equilibrium with the Jigsaw technique. Res Sci Educ 2008; 38(2): 249-60.
25. Tarhan L, Ayyıldız Y, Ogunc A, Sesen BA. A jigsaw cooperative learning application in elementary science and technology lessons: physical and chemical changes. Res Sci Technol Educ 2013; 31(2): 184-203.
26. Reime MH, Harris A, Aksnes J, Mikkelsen J. The most successful method in teaching nursing students infection control-E-learning or lecture? Nurse Educ Today 2008; 28(7): 798-806.
27. Şahin A. Effects of Jigsaw III technique on achievement in written expression. Asia Pacific Educ Rev 2011; 12(3): 427-35.
28. Leyva-Moral JM, Riu Camps M. Teaching research methods in nursing using Aronson's Jigsaw Technique. A cross-sectional survey of student satisfaction. Nurse Educ Today 2016; 40: 78-83.
29. Fagan MJ, Griffith RA, Obbard L, O'Connor CJ. Improving the physical diagnosis skills of third-year medical

students: A controlled trial of a literature-based curriculum. J Gen Intern Med 2003; 18(8): 652-5.
30. Chin C, Chia LG. Problem-based learning: Using students' questions to drive knowledge construction. Sci Educ 2004; 88: 707-27.
31. Buring SM, Kirby J, Conrad WF. A structured approach for teaching students to counsel self-care patients. Am J Pharm Educ 2007; 71(1): 08.
32. Tiantong M, Teemuangsai S. Student team achievement divisions (STAD) technique through the moodle to enhance learning achievement. Int Educ Stud 2013; 6(4): 85-92.
33. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, et al. Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci 2014; 111(23): 8410-5.
34. Abedin NFZ, Taib JM, Jamil HMT. Comparative study on course evaluation process: Students' and lecturers' perceptions. Procedia-Soc Behav Sci 2014; 123: 380-8.
35. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, et al. Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci 2014; 111(23): 8410-5.
36. Steinert Y, Snell LS. Interactive lecturing: Strategies for increasing participation in large group presentations. Med Teach 1999; 21(1): 37-42.
37. Haraldseid C, Friberg F, Aase K. Nursing students' perceptions of factors influencing their learning environment in a clinical skills laboratory: A qualitative study. Nurse Educ Today 2015; 35(9): e1-6.
38. White C, Bradley E, Martindale J, Roy P, Patel K, Yoon M, et al. Why are medical students "checking out" of active learning in a new curriculum? Med Educ 2014; 48(3): 315-24.
39. Charlier N, Van Der Stock L, Iserbyt P. Peer-assisted learning in cardiopulmonary resuscitation: The Jigsaw model. J Emerg Med 2016; 50(1): 67-73.
40. Şengül S, Katranci Y. Effects of Jigsaw technique on mathematics self-efficacy perceptions of seventh grade primary school students. Procedia-Soc Behav Sci 2014; 116: 333-8.
41. Smith MK, Wood WB, Krauter K, Knight JK. Combining peer discussion with instructor explanation increases student learning from in-class concept questions. CBE Life Sci Educ 2011; 10(1): 55-63.
42. Saltarelli W, Lee YK, Roseth C. Implementing a cooperative learning model in a cadaver anatomy laboratory. FASEB Journal Conf Exp Biol 2015; 29(1 Meeting Abstracts). Available from: http://www.fasebj.org/content/29/1_Supplement/205.3.abstract?sid=6e2447a4-6c10-4f66-8c1e-40ab50b4e2c8
43. Cooper MM, Cox CT, Nammouz M, Case E, Stevens R. An assessment of the effect of collaborative groups on students ' problem-solving strategies and abilities. J Chem Educ 2008; 85(6): 866-72.
44. Zakaria E, Chin L, Daud Y. The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. J Soc Sci 2010; 6(2): 272-5.
45. Krych AJ, March CN, Bryan RE, Peake BJ, Pawlina W, Carmichael SW. Reciprocal peer teaching: Students teaching students in the gross anatomy laboratory. Clin Anat 2005; 18(4): 296-301.
46. Rees C, Shepherd M. Students' and assessors' attitudes towards students' self-assessment of their personal and professional behaviours. Med Educ 2005; 39(1): 30-9.