23 (2), 2022, 505-518

Jurnal Pendidikan MIPA

e-ISSN: 2550-1313 | p-ISSN: 2087-9849

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Index Card Match Learning Model Integrated with Flipped Classroom to Improve Conceptual Understanding

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Abstract: This research aimed at improving students' conceptual understanding of the excretory system through index card match learning model (ICMLM) integrated with the flipped classroom. This study conducted a pre-experimental with One Group Pre-test-Post-test Design involving 16 students of Junior High School Muhammadiyah 7 Gresik grade VIII within a-twice meeting during limited face-to-face learning. The instruments consisted of pre-test and post-test, learning observation sheets, and questionnaires for student responses. Data collection used test and questionnaire method. Cognitive data analysis of concept understanding using t-test and N-Gain. The t-test result obtained a score of 0.000. Besides, the N-Gain test revealed an average score of 0.75, characterized in the high category. This test showed that students' understanding of concepts in detail is increased, namely, 7 students in the medium category and 9 students in the high category. Student responses after treatment were considered very good, with a percentage of 86.45%.

Keywords: concept understanding, flipped classroom, index card match learning model.

Abstrak: *Tujuan penelitian ini adalah meningkatkan pemahaman konsep siswa terhadap materi sistem ekskresi dengan penerapan model pembelajaran index card match yang terintegrasi pada flipped classroom. Desain penelitian adalah pre-experimental dengan rancangan One Group Pre-test-Post-test Design. Penelitian ini diujicobakan dua kali dengan 16 siswa kelas VIII A SMP Muhammadiyah 7 Cerme Gresik saat PTM terbatas. Perangkat yang diaplikasikan antara lain lembar pre-test dan post-test, lembar observasi keterlaksanaan pembelajaran, dan kuesioner respon siswa. Metode tes dan angket digunakan sebagai teknik pengumpulan data pada penelitian ini. Analisis data kognitif pemahaman konsep menggunakan uji-t dan N-Gain. Hasil uji-t didapatkan skor 0,000, sedangkan uji N-Gain diperoleh rata-rata sebesar 0,75 yang termasuk dalam kategori tinggi. Tes ini menunjukkan bahwa pemahaman konsep siswa secara detail meningkat dari 7 siswa dengan kategori sedang dan 9 siswa dengan kategori tinggi. Respon siswa setelah perlakuan dinilai sangat baik dengan persentase 86,45%*

Kata kunci: *pemahaman konsep, flipped classroom, model pembelajaran index card match.*

▪ INTRODUCTION

The abrupt implementation of Distance Learning (DL) policies in all schools during the Coronavirus outbreak receives multiple concerns from communities. They consider that such a DL is less effective because of poor internet connections and a lack of teacher skills to operate digital tools (Santosa, 2020). Students think that it is difficult to fulfil their competencies in cognitive skills only with online learning (Mahdy, 2020). The majority of students face difficulties in grasping the concepts of material when learning online. According to Mulyanti et al. (2020), students feel not more interested in DL than ordinary learning and lack learning motivation. Consequently, they fail to answer questions correctly when having midterm and final exams. Others found that unplanned DL also produces a significant decrease in student learning motivation since

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DOI: http://dx.doi.org/10.23960/jpmipa/v23i2.pp505-518
Received: 30 April 2022
Accepted: 11 June 2022
Published: 07 July 2022

the education program is not well-prepared online (Francom et al., 2021; El Refae et al., 2020).

To reduce the ineffectiveness of DL, the Ministry of Education and Culture of the Republic of Indonesia issued a policy of conducting limited face-to-face learning (LFFL). The implementation of LFFL is considered to be a solution to prevent further learning loss (decreased student cognitive skills), which will increase social participation between teachers and students so that the learning outcomes. Ellianawati et al. (2021) stated in their research that the student's pre-test and post-test in face-to-face learning are higher than in online learning, with 31.16% differences. The policy was then responded to very well by teachers and students. Fitriyani et al. (2022) revealed that the LFFL has at least helped students get better learning experiences than DL. Students also successfully escalate their excitement with the policy because they can comprehend the subject matter through intense class discussions and social interactions.

Despite receiving positive responses from various parties, LFFL still has some shortcomings in its implementation. It has not been able to overcome student learning problems because of restrictions on the schedule. Students can only go to school twice a week. Onde et al. (2021) indicated that the implementation of LFFL is less satisfactory in terms of increasing learning outcomes and levelling up student understanding of concepts. They pointed out that there are three causative factors: (1) minimal social interaction between teachers and students, (2) less interactive learning model, and (3) the lack of using innovative media. Regarding these results, Tanuwijaya & Tambunan (2021) obtained the fact that teachers are getting in a rush to deliver the learning material during LFFL; thus, their students hardly grasp the concepts.

Preliminary observation conducted in Junior High School Muhammadiyah 7, Cerme, Gresik involving 16 respondents of grade VIII reported that when learning using LFFL, students still hardly read the material, rarely submit assignments, and are less enthusiastic at school. When interviewed, some students answered that they could not understand the material being taught because the teacher seemed to only give assignments to do at home. Also, they only gave final answers to the assignments and only provided a little feedback. In this case, the teacher is unable to apply interactive learning model and media during LFFL. The impact of these can be seen in pre-test questions about Human Excretory System. Students tend to have misconceptions about three concepts. These include: 1) students looked similar function between ureter and urethra as they deliver the same fluid; 2) they think that nephrons just reabsorb ions, minerals, amino acids, and glucose, instead of water; 3) Students are unable to differ the concept of augmentation and tubular secretion. This difference is important to clearly explain the function of urea; not only as a waste product, but also for maintaining osmotic pressure in the nephrons. Based on the completeness of learning outcomes with the score $\geq$ 70, only 12.5% of the total students passed the pre-test. These results indicate that students are categorized as having a low level of conceptual understanding.

The flipped classroom is the learning model that can be applied to solve the problem. The flipped classroom is a student-oriented learning model (students are more active than teachers) with the knowledge that has been learned at home. This model is a modern way of structuring teaching that practice exercises class time (Mohammed & Daham, 2021). Flipped classroom uses principles that are inversely proportional to conventional learning or direct instruction. Learning is done before the class, while the

assignment is accomplished in the classroom (Sargent & Casey, 2020). In light of research, the flipped classroom can offer an excellent opportunity to promote students' conceptual understanding and the student's response as active class participants (Cevikbas & Kaiser, 2020). The use of the integrated flipped classroom in the challenge-based learning also shows that the implementation of such a learning process influences the increase in motivation, participation, and learning outcomes. The students rated the learning process as satisfactory efficiency (Rodriguez-Chueca et al., 2020).

Flipped classroom alone cannot be used to trigger enjoyment for student learning. Instead, the concept of gamification needs to be infused into the flipped classroom to initialize the appearance of student motivation to learn through social interaction (Sailer & Sailer, 2021). According to Ho (2020), students' behavioral, cognitive, and motivational engagement can be increased through a gamified flipped classroom. The Index Card Match Learning Model (MLM) is a game-based learning model with card media. This model is usually used to review the material that has been taught. However, this model can also be applied to new material if students are given the task of studying material related to the subject to be studied so that students already have knowledge when starting the lesson (Afandi et al., 2013). The implementation of this learning model is quite enjoyable. The concept of this model uses two kinds of cards, namely, cards containing questions and cards containing answers about the discussed topics. The cards will be shuffled and then distributed to students. Students must find their partner (question/answer) that matches the card they get. After finding their respective partners, students will present their results in front of the class. The advantages of this learning model consist of (1) creating joy during learning, (2) fostering an enthusiastic attitude and independent skills in students, and (3) providing a fun learning atmosphere (Helmiati, 2012). Rahmawati et al. (2011) stated that in biology learning, ICMLM was more effective in implementing and improving student learning outcomes. Based on previous research, ICMLM can be successfully implemented and better impact students' problem-solving ability than in the control class (Nuraeni & Rosyid, 2019).

According to the above explanation, this study reveals that the influence of ICMLM with flipped classroom increase students' understanding of concepts in the human excretory system material. The combination of the two learning models has the potential to be effective because learning activities are more centred on students.

▪ METHOD

Research Design and Procedures

This type of research is a pre-experimental research design with one group pre-test-post-test. The subjects of this study were 16 students (male n=6; female n=10) of class VII-A at Junior High School Muhammadiyah 7 Cerme Gresik. This study selected participants using a purposive sampling technique based on relevant considerations to the research (Sugiyono, 2015), such as low participation in learning, heterogeneity of students, and student score of completeness. This research was conducted for two meetings during LFFL in the even semester of the 2021/2022 academic year.

This research procedure included planning, applying treatment, and data analysis. The planning stage was the preparation of research instruments and learning tools consisting of the lesson plan, pre-test and post-test items, observation sheets, and questionnaire for student responses. The treatment stage consisted of giving a pre-test

before learning, applying the flipped classroom-ICMLM, post-testing, and student response questionnaires. Furthermore, the t-test and N-Gain test using SPSS v.25 was used at the data analysis stage to proceed with the data.

Research Instruments

Instruments used in this study consist of a cognitive test (pre-test and post-test), observation of learning implementation, and a questionnaire for student responses. Three experts (two lecturers and one science teacher) validated these instruments to determine their feasibility. All the instruments were considered valid because they got a percentage > 61% (Astriani et al., 2020).

The data were collected using a cognitive test (pre-test and post-test) and a questionnaire (observation sheet and students' responses). The test contains ten items in the form of a multiple-choice human excretory system. The cognitive test got an average validation result is 90% and is considered valid. To pass the test, students need to have a score of 70, which is determined by the school assessment system. According to the essential competencies of the human excretory system material, there are six indicators shown in table 1.

Table 1. Test instrument indicators

Test Question Indicators	Frequency
Identifying the parts of excretory organs and their functions	3 questions
Matching the excretory organs with the substances excreted	1 question
Mentioning the sequence of the urine formation process	1 question
Analyzing statements related to the excretory system, showing the part of the kidney nephron in the unlabeled picture, and the function of the liver as an excretory organ	3 questions
Attributing disorders or disease affected excretory organs	1 question
Summarizing the function of organs in the flow of urine formation picture	1 question

The questionnaire instruments consisted of an observation sheet on implementing the learning process and a student response questionnaire. The observation sheets use a Likert scale with a score range of 1 to 4, where a score of 1 is low, a score of 2 is quite good, a score of 3 is good, and a score of 4 is very good. Two observers determine the learning process by giving a checklist on the instrument in which 0% to 55% is categorized as negative, 56% to 75% as a medium, and 76% to 100% as positive (Purwanto, 2004). The average validation result of the observation sheet is 95% and is considered valid.

The student response questionnaire got an average validation result of 92% and was considered valid. This questionnaire consists of ten questions on the Guttman scale. The Guttman scale is a measurement scale using two intervals, namely "agree" and "disagree" or "yes" and "no" (Sugiyono, 2015). The Guttman scale portrays a firm answer regarding the effect of the flipped classroom-ICMLM on students. Student response questionnaires were administered in the form of Google form to maintain the confidentiality of respondents.

Table 2. Indicators of response instruments

Indicators	Statement Number
Satisfaction with the learning model	1,5,7
Conceptual understanding	3,4,6,8
Activeness during the learning process	2,9
Learning material compatibility	10

Data Analysis Techniques

The data analysis techniques used paired t-test and N-Gain. Before conducting the t-test, the study determined the normality test to know the data are normally distributed. The normality test used Kolmogorov-Smirnov test (One Sample K-S). Suppose the probability or (Sig.) > 0.05, then the data is said to be normally distributed (Budi, 2006). In this study, the normality test results were obtained at 0.107, meaning that the data were normally distributed. After the normality test, the next step was a paired t-test. This test uses a significance level (α) = 0.05. This test helps compare pre-test and post-test results (Arikunto, 2013). The t-test was performed using SPSS v.25. Parameters in this t-test if the value of Sig. (2 tailed) < 0.05 means Ha is accepted. These results indicate a significant difference between the pre-test and post-test, which tests the level of students' conceptual understanding (Nuryadi et al., 2017). Meanwhile, if the value of Sig. (2 tailed) > 0.05 means Ha is rejected where there is no significant difference between the pre-test and post-test, which tests the level of students' conceptual understanding.

Furthermore, the N-Gain test was carried out to determine the increase in student learning outcomes to interpret the level of understanding of students' concepts. The results of N-Gain will be interpreted as low category ($g < 0.3$), medium ($0.3 \leq g < 0.7$) and high ($g \geq 0.7$) (Hake, 1998). If the N-Gain data obtained scores with medium to high criteria, then there is an increase in understanding of students' concepts.

Student response questionnaires will be analyzed using a qualitative descriptive Guttman scale after the treatment with assessment; if students choose "Yes", they would be given a score of 1, and if students choose "No", they would be given a score of 0. Guttman scale was used to only give correct or incorrect responses to the statements in questionnaires (Osterhaus et al., 2022). From that assessment, the data will be calculated using the following formula:

$$\% \text{ response} = \frac{\Sigma \text{students choose "Yes"}}{\Sigma \text{all students}} \times 100\%$$

The percentage of results from the calculation of the formula above will be interpreted as very low (0-20%); low (21-40%); enough (41-60%); good (61-80%); and very good criteria (81-100%) (Riduwan, 2015). If the percentage obtained is 61% or above, it can be interpreted that students give a positive response to learning the flipped classroom-ICMLM.

▪ RESULT AND DISSCUSSION

Implementation of the Learning Process

To increase students' conceptual understanding, this research entailed flipped classroom-ICMLM. Two observers checked the instrument for the learning process to

assess the quality and suitability of the learning steps in the lesson plans compared to the practices in the classroom. The percentage of the results of each phase is shown in the following table.

Table 3. Percentage of learning process

Aspects	**Meeting 1**	**Meeting 2**
Introduction	100%	100%
Main	92.50%	97.50%
Closure	100%	100%
Average	97.50%	99.17%

According to Table 3, the learning process in each phase is 61%, indicating that the learning is carried out very well (Is'ad, 2022). In the introduction phase, the teacher greets to start learning, prays with students before learning, and checks student attendance. At the first meeting, an initial check of student knowledge was conducted to give a pre-test, which is also an aspect assessed on the observation sheet. The average percentage of implementation for the introduction phase is 100%, which means that this phase is going very well. The main phase consists of delivering the technical index card match game, the teacher monitoring the game, evaluating the presentation of each group pair, and giving appreciation to each group member. In this phase, the first meeting showed a percentage of 92.5%, while the second meeting was 97.5%. It can be concluded that this phase is very well implemented and showed an increase in the percentage of learning implementation. As for the last phase, the closing consists of conclusions from the learning outcomes and closing the learning with closing greetings. At the second meeting, post-test questions were administered to measure the final knowledge of students after getting flipped classroom-ICMLM. In this phase, the average percentage of learning shows a percentage of 100%, which means this learning phase is going very well. The average implementation of the learning process at meeting 1 showed a percentage of 97.50% while meeting 2 showed a percentage of 99.17%, which were both in the very good category.

Conceptual Understanding

The learning media used are in the form of question-and-answer cards. In practice, these cards are scrambled and distributed to students; then, students are given time to find pairs of cards they get (questions/answers). The total cards used are 32 cards, with details of 16 question cards and 16 answer cards during twice LFFL. The card design is colourful and attractive and consists of excretory system material illustrations. The cards are labelled "Q" for questions and "A" for answers on the top left, making it easier for students to find the pairs of cards they get. The following is an example of a card design used during the lesson.

Figure 1. Design of the card

The questions used on the cards consist of knowledge questions, comprehension questions, and analysis questions. Knowledge questions use keywords of what, who, where, and why. Comprehension questions require students to be able to answer based on their understanding in their own words. This question uses the keyword "describe, explain, and compare". Analytical questions require students to be able to conclude answers through in-depth identification of case studies (Usman, 2011).

On the Q-card, "Mention the excretory organs in humans" is a knowledge question card (level C1 remembering), where this question is asked to sharpen students' memories about mentioning the excretory organs are in humans after independent study at home. On the Q card, "Describe the process of urine formation" is a comprehension question where students are required to find answers based on their understanding of the process of urine formation. During the presentation, pairs of students will describe the process of urine formation based on the cards they get and point out where the process takes place on the picture. On the Q card, "Mr Budi often urinates at night. Mr Budi also feels tired and always hungry. When his urine was tested in the laboratory with benedict's test, his urine was brick red. Meanwhile, when tested with a biuret, his urine is yellowish. What disease does Mr Budi have?" this is an analytical question containing a problem that requires students to find the answer based on case studies. Students are required to find answers about diseases that attack the excretory organs with analytical methods based on material that has been studied at home. This type of question can increase students' analytical thinking, logical reasoning skills, and strong imagination (Saptono et al., 2013). Thus, these questions can improve students' understanding of concepts.

The level of understanding of students' concepts can be assumed from the results of paired t-test scores of pre-test and post-test, which measure the difference value of both. It is used to see the impacts of the treatment on the progress of student learning from pre-test to the post-test (Waluyo, 2020). As for measuring whether there is an increase in understanding of the concept or not, it is assumed from the N-Gain test. The material for the test is the excretory system material in humans.

The t-test used SPSS v.25 with a significance level (α) = 5%, and the results obtained t = -12.292, p = 0.000. The significance value is less than 0.05, so it can be interpreted that H0 (null hypothesis) is rejected while Ha (alternative hypothesis) is accepted (Idris et al., 2020). It means that there is a difference between the result of the pre-test and post-test after implementation of flipped classroom-index card match model, which is increased.

Furthermore, the N-Gain test was carried out to determine the increase in student's conceptual understanding after the treatment. The result obtained an average N-Gain of 0.75, which is included in the high category with details of 7 students in the medium category (44%) and 9 students in the high category (56%). From these results, it can be interpreted that there is an increase in students' understanding of concepts in the high category after treatment.

Increasing students' understanding of concepts in the excretory system material can be described in several indicators of competency achievement. The following figure describes the increase in student's conceptual understanding per indicator using the N-Gain test.

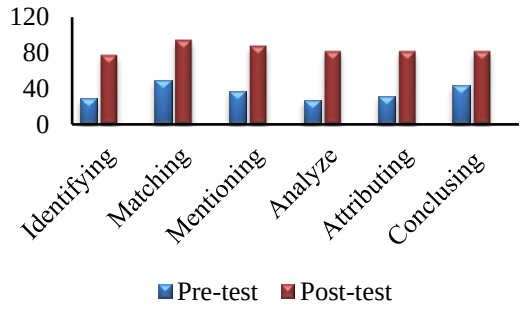

Figure 2. concept understanding per indicator

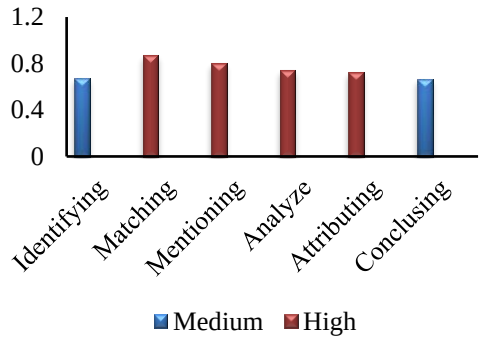

Figure 3. N-gain score per indicator

Based on those figures above, it can be seen that each indicator is categorized as medium and high. Indicators in the medium category include identifying and concluding indicators. The indicators in the high category include matching, mentioning, analyzing, and attributing indicators. The average category is high, so it can be assumed that there is an increase in student's conceptual understanding of indicators of competency achievement.

Aspects of identifying is an activity to determine or establish a piece of information about a concept. Assessment in this aspect is centered on remembering the information learned. The component measured in this aspect is information about the skin and lungs as excretory organs. The result of the N-Gain test is 0.67, classified as medium. In studying the excretory system, the material studied is mostly about memorizing, including the structure and function of the excretory organs. This indicator shows an increase in the average pre-test and post-test from 29.16 to 77.08, which means there is an increase in student's conceptual understanding of the structure and function of the excretory organs in humans.

The matching aspect includes activities to find a relationship between two concepts. The assessment on this aspect is that students are required to be able to match between the excretory organs and the substances released. The result of N-Gain is 0.87, classified as high. It is also seen that the average pre-test and post-test increased from 50 to 93.75. In this case, there is an increase in students' understanding of concepts where students can find the relationship between excretory organs and substances released

The mentioning aspect includes students' cognitive activities to restate the information provided. In this aspect, students must correctly name the sequence of urine formation processes in the kidneys. From the N-Gain results, 0.80 is classified as high. The average results of the pre-test and post-test increased from 37.7 to 87.50, so it can be concluded that students can correctly name the sequence of urine formation processes after treatment.

In the aspect of analyzing, students are required to be able to investigate an event/information and determine how the parts in a concept can relate to each other (Anderson et al., 2001). The results of the N-Gain obtained in this aspect are 0.74, which is considered high. Assessment of this aspect includes matters related/unrelated to the excretory system, analysis of the part of the kidney nephrons, and the relationship between liver function and the excretory system. From the pre-test and post-test results obtained, there is an increase from 27.08 to 81.25, so it means there is an increase in understanding of the concept of these indicators.

The attributing aspect involves assessing from the student's point of view the meaning of a concept. Based on the N-Gain results obtained, 0.72 is in the high category. Assessment of this aspect is a case study of disorders that attack organs in the excretory system. There is an increase in understanding of the concept of this indicator, as seen from the increase in the average pre-test from 31.25 to 81.25 in the post-test.

The concluding aspect involves the student's ability to abstract the concept that explains the example by observing the characteristics and connecting the characteristics. Assessment of this aspect includes conclusions from organ function in urine formation, as shown in the figure. Students are required to be able to conclude these functions just by looking at the designated pictures without being able to know what organs are designated. The results of N-Gain is 0.66, classified as moderate with an average pre-test of 43.37 and an average post-test of 81.25, which shows an increase in student's conceptual understanding of these indicators.

Understanding the science concept is one of the essential academic aspects for students to have. Concept understanding is a skill that is expected to be achieved in the learning process by showing the interrelationships between concepts and applying the concept appropriately (Darminto, 2011). Understanding science concepts can be done with an active and fun learning experience. Students get a detailed and precise understanding that is embedded in their long-term memory (Razak & Sudibyo, 2018). According to Slavin (2009), an educator can improve the storage of concepts in students' memory through the implementation of learning models that can create a memorable/not easily forgotten experience by providing visual images or auditory images (games, projects, using interactive media, or memorable lessons). The students taught with interactive media will increase their conceptual understanding and learning outcomes (Safaruddin et al., 2020). The flipped classroom-ICMLM integrates two modern learning models with innovations using interactive media (cards) whose

application can improve students' conceptual understanding because the learning process is fun and enjoyable. This increase in students' understanding of concepts can occur because, in applying the flipped classroom model, students must equip themselves with knowledge of the material before entering the classroom. When entering the classroom, the learning session will run effectively and maximally. The integration of flipped classroom with index card match is very appropriate because when students already have the preliminary knowledge, their knowledge will be reviewed or retrained with the index card match model, whose application is similar to games so that students feel fun and enthusiastic participating in the learning process.

Students' Responses

After the learning was carried out, student response data was obtained from the questionnaire distributed via the google form link at the last meeting. Student response questionnaire data can interpret how students respond to flipped classroom-ICMLM on the excretory system material. In addition, this response questionnaire data reflects the learning model that has been carried out, knowing the strengths and weaknesses during learning so that it can provide input and suggestions for the implementation of this learning model in the future. The following data were taken from student response questionnaires that have been analyzed using the Guttman scale.

Table 4. Results of students' response questionnaires

Statement	Percentage	Criteria
The learning model is fun and not boring.	81.25%	Very Good
The learning model supports me in becoming an active participant.	81.25%	Very Good
The learning model has improved my understanding of concepts.	87.50%	Very Good
The learning model elaborates my extensive knowledge.	87.50%	Very Good
The material taught becomes more fun and easier to learn.	93.75%	Very Good
The explanation from the teacher is easy to understand.	87.50%	Very Good
I feel excited while following the lesson.	84.37%	Very Good
After following the learning session, I understand the excretory system material in humans better.	87.50%	Very Good
Pre-test and post-test are suitable with the material	87.50%	Very Good
Average	**86.45%**	**Very Good**

According to the table, student response questionnaire statements received responses with very good criteria for each statement. Each statement received a positive response as evidenced by the acquisition of a score, namely each question 81%, whereas in this study, an average of 86.45% was obtained with very good criteria (Riduwan, 2015).

From the results obtained, the flipped classroom-ICMLM on the excretory system material was successfully implemented very well based on the positive response from the students. The ICMLM can facilitate students to visualize the material delivered by the teacher, so their enthusiasm for learning is increased (Hidayat et al., 2020). According to Amir et al. (2021) in their research, the index card match learning model

is proven to be able to increase students' motivation and cognitive learning outcomes, which also has an impact on students' conceptual understanding because the learning process is active and fun so that students respond well to the application of the index card match learning model. That previous research is equivalent to this research, and students respond positively to the implementation of the flipped classroom-index card match learning model because learning is fun, creative, and very motivating for students to be active during learning which has a positive impact on increasing students' conceptual understanding.

▪ CONCLUSION

Based on the research that has been done, it can be concluded that the implementation of the flipped classroom-index card match learning model on the excretory system material has been carried out very well. The level of understanding of students' concepts has increased in the high category, as evidenced by the N-Gain value of 0.75. After applying the flipped classroom-ICMLM, Student responses were very good, with an average of 86.45%.

Suggestions for future research, it would be better to use a sample with a higher quantity so that the data obtained shows more of the effect of implementing the related learning model. The learning media used are also more varied so that students' motivation to learn is high. If using the flipped classroom learning model, the teacher must be able to ensure that students already have a stock of knowledge before entering the class. The results of this study can be used as a reference for other researchers with further identification of their influence on other aspects, such as other subjects or their impact on aspects of learning motivation.

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