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Flipperentiated Learning in Biology Class to Improve Cognitive Learning Outcomes, Problem-Solving Skill, and Motivation

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ABSTRACT

The background of this research began with an apprehension of the need for students' learning in accordance with their learning abilities relating to the application of a flipped classroom model in the Biology class of XYZ Senior High School. Preliminary research showed the different needs of individual students; thus, differentiated learning was required especially in the face-to-face meeting in class. Differentiated learning aims to facilitate the different needs of the students based on the level of readiness, learning style preference, and interest. This research aimed at improving the students' learning and its impact on students' cognitive learning outcomes, problem-solving skills development, and learning motivation through the differentiated flipped classroom. The method used in this research was Classroom Action Research. The data were collected through observation, interviews, questionnaires, and evaluation of assessment results based on rubrics and marking schemes. All three variables are measured using rubrics separated from each other. These data are analyzed qualitatively and given a score in quantitative values. In three cycles of action research, the students' learning outcomes cognitively showed a significant increase from the first cycle to the second cycle. From the second cycle to the third cycle, there was a decrease but the decline was not significant. The problem-solving skills increase from the first cycle to the second cycle. In the third cycle, there was an increase until it reached the specified success indicator. In each cycle, the motivation did not increase significantly and tended to be stable but the Attention-Relevance-Confident-Satisfaction (ARCS) motivation model had reached the indicators of the success of the study. The conclusions of this research indicated improvements in the students' problem-solving skills, a high average in motivation indicators, and a significant improvement in cognitive learning outcomes.

Key words: Flipped Classroom, Flipperentiated, Differentiated, Stations Instructional Strategies, Problem-Solving Skills, Learning Motivation, Cognitive Learning Outcomes, Classroom Action Research

INTRODUCTION

The learning model is a pattern used in planning a learning process that includes all face-to-face activities and tools, materials, and media to be used in teaching (Tahir, 2012). Flipped classroom learning model has the concept as follows: what is usually done in traditional classes is converted into activities at home, whereas what is usually done at home in traditional learning models is transformed into activities at school. Thus, in the model flipped classroom material teaching activities are carried out at home through videos and reading the material, while practice questions that are usually done at home are now done at school (Bergmann & Sams, 2012).

Class XI and XII Biology subjects XYZ School has applied the flipped classroom learning model for one year. However, guided discussion activities conducted in the classroom cannot facilitate students' differences regarding the level of readiness, learning preferences, and interest in learning. Thus there is no significant increase in cognitive learning outcomes, (Bergmann & Sams, 2012) problem-solving skills, and learning motivation, especially among students with low achievement.

The use of the flipped classroom supported the results of previous studies conducted by Unal and Unal (2017). Their research compares cognitive learning outcomes between students studying in traditional classrooms and students learning in the flipped classroom model. In each treatment class, students were given the same pre-test and post-test for the same learning material, then the results were compared and analyzed statistically. Statistical test results show a real difference between traditional learning and the flipped classroom, where cognitive learning outcomes with flipped classrooms increase significantly.

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This research was conducted by applying a flipped classroom learning approach with the differentiated ability of student's learning. Implementation of a flipped classroom with additional differentiated student's learning could become a differentiated flipped classroom or abbreviated to be flipperentiated. This research uses the Classroom Action Research method through the station's instructional strategies into the learning model to improve cognitive learning outcomes, problem-solving skills, and learning motivation, especially among students with low achievement. Thus the purpose of this study is:

1. How is the improvement of cognitive learning outcomes of students during the application of instructional strategies to stations in the flipperentiated learning model?
2. How is the improvement of students in problem-solving skills during the application of instructional strategies of stations in the flipperentiated learning model?
3. How is the improvement of student learning motivation during the application of the instructional strategies of the stations in the flipperentiated learning model?

The Theoretical Basis of Flipperentiated Learning Model

The differences among students who have a focus of attention in this study include learning readiness, learning preferences, and interest in learning. According to Tomlinson (2014), learning readiness or readiness is the student's initial position relative to knowledge, understanding, or skill. In the context of the flipped classroom learning model, students tend to have an adequate level of readiness because learning materials have been learned at home through the videos and reading material provided. However, this level of readiness is also influenced by other factors; namely mastery of the learning approach, which includes the ability to listen to videos, take notes, and time management.

Learning preferences are defined by Pashler et al. (2008) as one's preference for receiving new information and learning processes. Some examples of learning profiles are whether students tend to need independent learning or through discussion, whether students need to see the big picture before learning the details or vice versa, whether students prefer learning with an applied analytical or creative logical approach. (Tomlinson, 2014).

According to Tomlinson (2014), interest in learning or interest defined as a student's interest, curiosity, or aversion to a particular topic or skill. Interest in learning about a particular topic can be generated by connecting the topic with something that is a favorite of a student. Dweck in Heidi and Regginer (1992) said that interest greatly influences a student's motivation to learn.

These differences can be facilitated by differentiating the learning process. Tomlinson and Allan (2000) defined differentiation as the teacher's actions that are responsive to a student's needs'. They also explained that the purpose of differentiated learning was to maximize the growth and individual success of each student. In doing differentiation, one teacher can do this in aspects of content, processes, and learning products that are tailored based on readiness, interests, and student learning preferences (Tomlinson, 2014).

The instructional strategies used in this learning model are stations. Instructional strategies are likened to 'baskets' that teachers can use to convey content, processes, and products (Tomlinson, 2014). Stations are defined as several different places where students will work on several simultaneous task variations (Tomlinson, 2014). In its implementation, students are divided into several groups consisting of three to five people. In the classroom, there are several places with different activities equipped with devices that support these activities. Then each group will get a set amount of time to work on activities that are in one station.

In the context of differentiated learning, this instructional strategy is modified (Tomlinson, 2014). Modifications that occur are flexibility in dividing students into groups because not all stations must be visited by each student. The time needed to complete the tasks given at each station is also flexible, i.e. students do not have to complete each station with the same duration. Likewise, with the selection of stations that must be visited, the teacher does not always require students to visit certain stations, but at certain times students can choose the station he wants.

Cognitive Learning Outcomes, Problem Solving Skills, and Motivation

Tasks in stations, including videos in the flipped classroom, designed based on indicators of the variables to be measured in the results of the study. These variables are cognitive learning outcomes, problem-solving skills, and motivation based on the Attention-Relevance-Confident-Satisfaction (ARCS) model.

Cognitive learning outcomes are learning outcomes related to changes obtained in the form of knowledge at the end of the learning process. According to Anderson and Krathwohl (2009), in its revision to Bloom's taxonomy says that there are six dimensions of processes that occur in the cognitive domain, namely: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5) and creating (C6). Processes C1, C2, C3 are basic cognitive process abilities while C4, C5, and C6 characterize high-level thinking skills (high order thinking). It is hoped that lesson along with the effective learning process and the development of cognitive abilities, students will be able to achieve the learning objectives to the highest level, C6.

According to Robert Gagné's learning theory (1985), problem-solving skills consist of three skills, namely:

1) Intellectual skills: mastering the rules, concepts, and principles needed to solve problems.
2) Organizing verbal information in the form of a scheme so you can truly understand the problem given.
3) Cognitive strategies that enable students to choose information and skills and decide when and how to use them in solving problems.

ARCS motivational design model (Attention - Relevance - Confidence - Satisfaction) was formulated by John M.

Keller (2010). This model is used because it is seen as the most influential model in the field of instructional design (Hess, 2015). It is because the ARCS model directly teaches instructional designers how they can design learning experiences and instructional interactions to foster students' intrinsic and extrinsic motivation. Akkaraju (2016) conducted a study of the application of the flipped classroom model to student learning motivation at City University of New York, by measuring it qualitatively based on interviews, observing student participation levels in working online quizzes after watching videos at home, and timeliness of students in attending class. Hess (2015) also mentioned the need for learning designs that can increase student motivation in learning.

METHODOLOGY

This study uses the Classroom Action Research method (CAR). The Classroom Action Research is one form of action research classified in the type of qualitative research. The model of this action research uses the model by Kemmis et al. (2014) They proposed a spiral model comprising four steps: Planning, acting, observing, and reflecting. This action research aims to improve the rationale and check the accuracy of the actions taken, understand the actions taken, as well as the situation or organization where the action was carried out (Wardhani & Wihardit, 2014). Classroom Action Research is done through the station's instructional strategies into the learning model with a series of cycles' process of learning consisting of planning changes, implementing and observing changes, reflection, re-planning, and so on until the desired results are achieved.

This research took place at XYZ School which is a school that uses the International Baccalaureate Diploma Program (IBDP) curriculum. The research runs from September 2017 to November 2017. The subjects (n = 20) of the study are Biology students of class XI. All the students are able to speak English well; even some students use English as their main language.

The research procedure is carried out by carrying out four main steps in the Classroom Action Research, namely:

1) Identifying the problem: this step is done by reflecting or reflecting on the flipped classroom application model which has lasted for a year to be able to recognize the shortcomings that exist.
2) Analyzing and formulate problems: the analysis is carried out by distributing questionnaires to students, reviewing the written test results of students' tests, and reflecting deeper using guide questions.
3) Planning Classroom Action Research: looking for alternative solutions to solve problems through a literature search. The reference to the theoretical basis used in planning corrective actions of this research is differentiated learning and instructional strategies of stations by Tomlinson (2014), the domain of cognitive processes of Bloom Revised Taxonomy 2001, revised by Anderson and Krathwohl (2009), problem-solving skills by Gagné (1985), and models ARCS motivation by Keller (2010). Application mapping theoretical foundation in planning flipperentiated learning models, as an alternative solution to solving research problems, can be seen in Table 1.
4) Implement Classroom Action Research: carried out in three cycles and each cycle consists of four stages (planning, action, observation, and reflection), with three periods of learning in a week.

Indicators of problem-solving skills:

1) Understanding the case study problem,
2) Analyze graph data and (or) tables in case study problems,
3) Apply relevant concepts to solve case study problems.

The summary of variables, indicators, data collection techniques, instruments, and sources of information in this study is as written in Table 2.

Table 1. Application mapping theoretical platform into all aspects of action plan for improvement

Steps process in Flipperentiated learning model	Cognitive learning result dimension	Problem solving skill*	ARCS motivation model
Video	C1, C2	-	Attention
Taking a note from the video	C1, C2	-	-
Discussion from video material	C1, C2	-	Relevance
Explanation of deep differentiation Doing task in stations	-	-	Attention, Relevance
station I: Terminology	C1	-	Relevance, Confidence
Station II: Working paper	C2, C3, C4	-	Relevance, Confidence
Station III: problems group	C1, C2, C3, C4, C5, C6	Indicator 1,2,3	Relevance, Confidence
Stasiun IV: work practice	C4, C5, C6	Indicator 1,2,3	Attention, Relevance, Satisfaction
Examine goal achievement learning	-	-	Confidence
Written test	C1, C2, C3, C4, C5, C6	Indicator 1,2,3	Satisfaction

Table 2. Variables, Indicators, Instruments, Data Collection Techniques, and Data Sources used in this research.

Variables	Indicators	Methods	Indicator	Information
Cognitive learning results	On scales 1-3 students are able to: • answer questions in the process dimension cognitive recall (C1) and understand (C2). • answer questions in the process dimension cognitive application (C3). • answer questions in the cognitive dimension; analyze (C4), evaluate (C5), and create (C6).	Document analysis	Rubrics	Results from written Exam Done by students
Problem-solving skill in Biology	On a scale of 1-3 students are able to: • understand the problem in biology case studies given. • analyze graph data and (or) a table in Biology case study problems • apply relevant concepts to solve Biology case study problems biological.	Document analysis	Rubrics	Results from case study the question in the exam writing
Learning Motivation	The scale of 1-5 Likert indicates the student has motivation based on: • Attention: perceptual arousal, inquiry, arousal, variability • Relevance: goal orientation, motive, matching, familiarity • Confidence: learning requirement, success opportunities, personal control • Satisfaction: natural consequences, positive consequences, equity	Response Form	Questionnaire	The result from Students' responses

The indicators of success for each variable are as follows:

1) In the cognitive learning outcome variable, success is considered to be achieved if 18 out of 20 students (90% of the population) succeed in achieving a score of two or more for each indicator in measuring cognitive learning outcome variables based on the results of the written exam.
2) In the problem-solving skill variable, success is considered to be achieved if 18 out of 20 students (90% of the population) can achieve a score of two or more for each indicator of problem-solving skills in the case study problem in the written test.
3) Students as a whole show an average value of four or more for their level of motivation based on their assessment of the indicators ARCS motivation model. Data collected will be selected and organized in various forms that can facilitate interpretation of data, for example in the form of narratives, graphs, and tables. From the interpretation of the data carried out then conclusions are drawn to answer the research questions that have been formulated.

FINDINGS

In this study, the Classroom Action Research cycle was carried out three times until it was expected that the desired results could be achieved. Kemmis et al.'s cycle (2014) consists of four stages, namely planning, actions, observation, and reflection. Each cycle lasts ten meetings and each meeting is 45 minutes long.

Cycle 1 Process

a) Planing

This step starts with making a learning plan. In the first cycle, the topics given in the form of videos were Membrane Transport and Cell Life Cycles. Video of material also applies the ARCS motivation model in aspects of attention by providing interesting facts about discovery cycling (regulator of cell division) accidentally, and ethical questions that are of nature open-ended related to smoking as a cause of cancer. Tasks in each station are also arranged, namely in the form of terminology sheet (station I), concept worksheet (station II), collection of question banks (station III), and practice sheets (station IV). Practicum task station IV is observing onion root cells to calculate the mitotic index. Videos, task sheets for all stations, and learning objectives uploaded to the page Microsoft OneNote which is used as the platform in model learning flipperentiated this.

b) Acting

Students get access to the video three days before the class meeting so that they can listen and take notes of the video at home. At class meetings, students provide input on the duration of the video and its proposed availability offline. After an examination of records, students are given an explanation of differentiation in the learning flipped classroom model. Some students can immediately learn in an orderly manner, both in groups and independently. Almost all students visit the station according to the order, but there is a small number who are more interested in doing practicum first. During the learning process, active students ask to clarify their understanding. However, there were some students who had been observed chatting. After eight meetings

passed, students were asked to report the fulfillment of their duties at each station. Nearly 50% of students fail to complete all assignments, so they are given extra time during lunch hours. This cycle is closed by discussing the achievement of learning objectives based on syllabus and written examinations the following week.

c) Observing

In observations, observed several students appeared to be less disciplined in working on the tasks of each station. The results of the questionnaire say that students assess motivational drivers in terms of attention and relevance high enough. Cognitive learning outcomes measured from the test written in this first cycle have not reached the achievement target and in the questionnaire, some students gave a fairly low value for the aspect confidence and satisfaction. Problem-solving skills of students are also still quite low, especially in identifying problems in the case study problem. In the results of interviews with students, it was found that the need for a short lecture was input because the delivery of material through the video did not provide interaction as in lecture activities. Some students also said the need for tighter control in fulfilling tasks so that students were more motivated in completing the tasks of each station. The students also say that the flipperentiated model allows them to get more teacher assistance.

d) Reflecting

The success of the flipperentiated learning model is largely determined by the discipline of students in completing station assignments. From the observations, it seems that students seem to still need external disciplines who will encourage them to fulfill these tasks. In terms of problem-solving skills, it appears that students need training in problem-solving techniques, especially in identifying problems and analyzing table or graph data. The lecture learning method also turns out that some students still need it because it can provoke interactions that lead them to explore deeper concepts.

Cycle 2 Process

a) Planing

Based on the reflection of the first cycle, improvements were made in the implementation of the flipperentiated learning model in the second cycle by providing regulations in fulfilling station assignments that affect the grades of the quarterly report cards of students. This regulation is expected to increase student discipline in carrying out the duties of each station. Also, to emphasize the element of discipline, in the second cycle, reporting on the completion of tasks is carried out openly where students fill out the fulfillment of their duties on the board in the classroom. Short lectures will also be given after the activity checks the notes to briefly discuss the material contained in the video. Training to help students identify problems and analyze data in the case study questions will also be provided as part of the activities at station III. The topic of cycle II is the Hierarchy and Energy Flow in Ecosystems. To improve aspects of attention based on the ARCS motivation model, the station I activities will be online games *Kahoot!* to provide a variety of activities for students. The concept worksheet is prepared for station II and the question bank for station III. Station IV practical activities will be in the form of observing and designing factors mesocosm as an ecosystem model.

b) Acting

The short lecture made succeeded in making the class discussion deeper about the concept of energy flow so that students could relate it directly to everyday life. This makes some students appear more motivated in following cycle II learning. Online quiz *Kahoot!* In the station, we were enthusiastically followed by all students. Training on problem identification techniques at station III makes students feel more confident in their problem-solving skills. The percentage of students doing each station's tasks also increases with the enactment of the value rules in fulfilling the task. This second cycle ended with a discussion of the achievement of learning objectives based on syllabus and written examinations the following week.

c) Observing

Cognitive learning outcomes measured through written examinations in cycle II increased significantly and succeeded in achieving established success indicators. Students' skills in solving problems also increase, especially in the ability to analyze table and graph data. However, the indicators of writing concepts that are relevant to solving problems still have not reached the indicator of success. Motivation questionnaire results also showed an increase along with students' cognitive learning outcomes that were more satisfying. From the results of interviews with students, they claimed to prefer cycle learning II because of the lecture, more strict rules in completing station tasks, and variations in activities at the station I.

d) Reflecting

The lecture's method is increasingly proven to be needed by students because it does not need to be tabulated in the flipperentiated learning model because it can produce a sharpening of the concept through discussion with teachers and fellow students. This is in accordance with Lev Vygotsky's cognitive development learning theory which says that collaborative problem solving maximizes learning (Gredler, 1997). In this second cycle, there are still students who have not succeeded in completing the tasks in the station. It seems that students need to be helped to make achievement targets at the beginning of the series to complete station tasks so that they are efficient and effective in using time. The results of written examinations stating weaknesses in using relevant concepts to solve problems need to be addressed in the next cycle, for example by evaluating the answers to questions about case studies together.

Cycle 3 Process

a) Planing

Based on the reflection of cycle II, in cycle III students will be asked to plan time allocation in completing tasks in each station. This time allocation must be used by students to monitor the target of completing station tasks. Before carrying out the task of station III, training was conducted again to improve problem-solving skills by evaluating the answers to

the case study questions in the written cycle II test together.

The third cycle topic is the Carbon Cycle and Global Warming. To improve aspects relevant based on the ARCS motivational model, in addition to practicing calculating biomass using a simple calorimeter, station IV activities will be added by making a simple project to reduce carbon emissions in the daily activities of students.

The concept worksheet is prepared for station II and the question bank for station III.

b) Acting

The lecture in the third cycle took place intensively because it was related to the issue of global warming which was controversial when this research was conducted. In the discussion, students get the opportunity to explore political, economic, ethical, and limitations of science. Creative ideas then emerge in designing simple projects to reduce carbon emissions, for example by making a diet vegetarian for a week.

Calorimeter data analysis and evaluation of the weaknesses of simple calorimeters provoke critical analysis of students, and it seems that this helped sharpen students' skills in solving case study problems. At the time of reporting the fulfillment of each station's assignments, it was found that all students succeeded in fulfilling the tasks of all stations. The third cycle ends with a discussion of the achievement of learning objectives based on syllabus and written examinations the following week.

c) Observing

The majority of students in the third cycle are more active and participatory in working on the tasks of each station. This shows the time factor to grow new habits as Edward Thorndike said in behavioral behavior learning. Thorndike said that repetitive training will improve proficiency (Gredler, 1997). Cognitive learning outcomes measured based on written test results have achieved success indicators despite a slight decrease in the C4-C6 indicator. This is probably due to the topic of the carbon cycle which involves several chemical reactions. The problem-solving skills in this third cycle finally succeeded in achieving an indicator of success where 100% of students managed to achieve a score of two or more for each indicator of problem-solving skills.

The learning motivation questionnaire showed a slight decrease in almost all aspects. Apparently, this is caused by a decrease in the results of written examinations and the existence of material related to chemical reactions that are quite difficult for some students.

d) Reflecting

The third cycle reflects a flipperentiated learning model that has succeeded in becoming a new habit in students who can improve cognitive learning outcomes, problem-solving skills and also increase their learning motivation. The problem-solving increases from pretest to posttest from cycle I to cycle III, and it can be said that a flipperenciated learning model will increase the problem-solving skills. However, the aspect of motivation is quite easy to change especially if students feel the material being studied is quite difficult and there is a decrease in the results of written examinations. Thus the attention of teachers is needed to provide additional assistance for material related to other subjects that may not be overly mastered by students.

The Summary of the Test

The summary of classification of written test on each cycle based on the indicator of cognitive process dimensions illustrated in Table 3.

Student answers to be examined using the rating scale in the answer key. The scores obtained in each level of the cognitive process dimension are then measured using cognitive learning outcome indicators and the results are listed in Table 4.

The scores obtained in each level of achieving indicators of skills in solving cycle I, II, and III Problems Table 5.

The scores obtained in the Value of ARCS Motivation Model Cycle I, II, III Problems Table 6.

DISCUSSION

The cognitive assessment has proceeded in each station. The cognitive rubric consists of a rubric of terminology sheet (station I), concept worksheet (station II), collection of question banks (station III), and practice sheets (station IV). From the result above we could give some remarks.

1) Analysis of the development of cognitive learning outcomes of students

The written test given has items that can measure all levels of the cognitive process dimension C1 to C6. Each written test consists of eight questions and the classification of the questions can be seen in Table 3.

In each cycle, the ability of students to answer questions increases, the success indicator determined in this study reaches 90% of students can get a score of two or more in each indicator of cognitive learning outcomes formulated based on the cognitive dimensions of Bloom's Taxonomy by Iwaniec et al. (2017) which shows the development of problem-solving skills when students conduct learning with the flipped classroom model. Correspondingly, Ghoneim (2017) in her research on differentiated learning, also reported that cognitive understanding of the subject matter could increase by using differentiated learning.

The value of two in the cognitive learning rubric indicates that students succeed in answering most of the questions for each level of classification in the cognitive process dimension. Cycle I cognitive learning outcomes have not succeeded in achieving the target of success. The possibility of this is due to the process of adaptation of students to learn in the flipperentiated model. Besides, as written in the results of the reflection of the first cycle, students still need help in the techniques needed to solve problems in case study questions. Learning habits in the flipperentiated model and technical training to understand the problem in the case study problem turned out to be a booster for the cognitive learning outcomes of students in cycles II and III. Indicators of the success of cognitive learning outcomes are achieved both in cycle II and cycle III. The results obtained that the flipperentiated learning model has given benefits in improving cognitive learning outcomes. These results corresponding to the

Table 3. Classification of written test questions based on indicators of cognitive process dimensions

Process dimension indicator bloom's cognitive taxonomy revision	Number of problems type of question		
	Cycle I	**Cycle II**	**Cycle III**
C1, C2	2, 3, 6e (3 questions)	1, 2, 6c, 8 (4 questions)	1, 2, 4, 7 (4 questions)
C3	1, 4, 5, 6a, 8 (5 questions)	3, 4, 6a, 6e, 6f (5 questions)	3, 6b, 6d, 6h, 8 (5 questions)
C4, C5, C6	6b, 6c, 6d, 6f, 6g, 7 (6 questions)	5, 6b, 6d, 7 (4 questions)	5, 6c, 6e, 6f, 6g (5 questions)

Table 4. Achievement of Cognitive Cycle I, II, and III Learning Outcomes Indicators

Cycle	**I**			**II**			**III**		
Indicators	1	2	3	1	2	3	1	2	3
Number of students who reaches ≥ 2	9	16	12	19	20	19	20	20	18
Percentage of students who reaches ≥ 2	45	80	60	95	100	95	100	100	90

Table 5. Achieving Indicators of Skills in Problem Solving Cycle I, II, and III Problems

Cycle	**I**			**II**			**III**		
Indicators	1	2	3	1	2	3	1	2	3
Student Total of students who reaches ≥ 2	18	16	16	18	20	16	20	20	20
Total Percentage of students who reaches from Pretest problem ≥2	80	70	80	90	80	80	90	100	80
Total Percentage of students who reaches from Posttest problem ≥ 2	90	80	80	90	100	80	100	100	100

Table 6. Average value of ARCS motivation model cycle I, II, III

Cycle	**Cycle average indicator value concerning ARCS motivation model**
I	4.0
II	4.1
III	4.0

research of Demetry (2010) that the right design of flip classroom learning would be able to improve learning outcomes.

2) Analysis of the development of student skills in solving problems The problem of case studies in written examinations are also analyzed using problem-solving rubrics and results can be seen in Table 5.

In the first cycle, the first indicator that measures students' ability to identify problems in a case study has reached the level of success they want to achieve in this study, which is obtaining a score of two or more. While indicators two and three, which measure students' ability to analyze table and graph data and the ability to apply relevant concepts have not reached the target level of success. In cycle II, the author provided training in reading table and graph data in the case study, and it seems that this corrective action produced results so that the second indicator in problem-solving skills also managed to reach even exceed the target of success. But in the second cycle, the third indicator has not yet succeeded in achieving its target of success. This is probably due to the amount of time and frequency practicing for students in mastering the third aspect of this problem-solving skill. This guess is supported by data in cycle III where all students finally reach a score of two or more on all indicators. Based on data analysis of problem-solving skills it can be said that the flipperentiated learning model is managed to improve students' solving skills problems and reach indicators of success in cycle III. Similarly, Nouri's (2016) findings showed that the challenge of problem-solving skill learning would increase the student's skill in problem-solving.

3) Analysis of the development of student learning motivation

Student learning motivation was analyzed based on the average score given by students in the questionnaire for each indicator of the measured learning motivation model of ARCS, namely attention, relevance, confidence, and satisfaction. The average score of all ARCS sub-indicators from cycles I, II, and III can be seen in Table 6.

Each indicator is assessed by students based on a 1-5 Likert scale. In Table 6 it can be seen that the average value of the indicator for each cycle has reached four or more. Thus it can be said that the flipperentiated learning method can achieve indicators of research success set for motivation variables. A similar statement was also expressed by Tomlinson and McTighe (2006) who said interest is very influential on a student's motivation to learn. High interest will bring high motivation to learn and give birth to good learning outcomes as well. Similarly, with that statement, Heidi and Renninger (1992) also mentioned that interest will increase motivation in learning knowledge or skills.

CONCLUSION

The students' learning outcomes cognitively show a significant increase from cycle I to cycle II. From cycle II to cycle III, there is a decrease but the decline was not significant. Cognitive learning outcomes of students in cycles II and III succeeded in achieving the success indicators determined

in this study. Problem-solving skills increase from cycle I to cycle II. However, in the second cycle, the success indicators determined for problem-solving skills have not been achieved. In the third cycle, there was an increase until it reached the specified success indicator, where all students were able to achieve a score of two or more in all indicators of the problem-solving skill variable. The development of student motivation measured using the ARCS motivation model in each cycle has reached four or more according to the indicators of the success of the study.

To implement and develop flipperentiated learning methods, it is recommended to prepare in advance to make videos and assignments that will be given at each station. It also provides all videos, reading material, and assignments in the offline form to overcome internet network constraints and computer technical problems. Conducting further research on strategies for designing videos is as attractive as possible for students, especially by using real cases in their lives. Examine the prior knowledge of students related to new material so that if there is a shortage it can be addressed before entering a new material.

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