

**SCIENTIFIC LITERACY-BASED FLIPPED CLASSROOM VIRTUAL STRATEGY FOR BIOLOGY LEARNING IN THE NEW NORMAL ERA****S. Ridlo^{*1}, H. Marina², D. Sapitri², L. N. Hadiyanti¹, Listyono³**¹Universitas Negeri Semarang, Indonesia²Alumni of Universitas Negeri Semarang, Indonesia³Universitas Islam Negeri Walisongo Semarang, Indonesia

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Accepted: August 16th 2022. Approved: December 29th 2022. Published: December 30th 2022**ABSTRACT**

Various research results concerned with flipped classrooms reported to mandate more benefits to form a positive attitude, self-efficacy, and self-regulated learning and affect students' abilities and skills. This research, which involved three studies, aims to develop a flipped classroom strategy model for virtual biology learning. The research was conducted in three high schools and the Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, at the beginning of the new normal habit of the COVID-19 pandemic. The analysis results of study 1 were applied in designing study 2, and the results of study 2 were applied to develop the model in study 3. The results showed that the flipped strategy was proven to improve skills employing information technology to benefit learning and student participation. The flipped strategy is proven to have better effects on learning outcomes and students' self-efficacy. The strategy model, arranged with asynchronous-synchronous-asynchronous in scientific literacy-based learning syntax and practiced with flipped e-learning instructions, is an ideal flipped classroom model. It is well appreciated by validators, teachers, and students and has proven to function well.

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Keywords: biology learning; flipped classroom; virtual strategy

INTRODUCTION

The COVID-19 pandemic completely disrupted the Revolutionary Era 4.0, and education was no exception. Various forms of new literacy that accompany the demands of this era's skills are increasingly being accelerated to fulfill them. Nadiem Makarim, in his remarks for the UNNES Anniversary on March 30, 2021, said, "In the current era, education should no longer be limited by building barriers... Students should be given the widest opportunity." Individual academics are no longer likely to focus on teaching and the academic discipline in isolation. The burden for teachers and lecturers is becoming increasingly heavy, considering that each must try to make themselves literate about data, technology, and

humans. At the same time, teachers and lecturers must be able to bring their students literate towards the same thing. Brinia and Davim (2020) stated that there was a need for a new reorientation and reform in implementing education. In line with the Minister of Education and Culture's statement, one of the new forms of reorientation is easy because of broader access to learning, including online learning.

The flipped classroom was born as a form of nontraditional teaching (Williams et al., 2018; Safapour et al., 2019; Soetikno et al., 2019; Webb & Doman, 2020). Flipped classroom traditionally turns activities carried out in the classroom (e.g., content presentation) into activities at home, and activities such as homework become classroom activities (Sohrabi & Iraj, 2016; Zainuddin et al., 2019). In this classroom model, teachers help students convey information, are responsible

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for their learning process and must regulate their learning pace (Lai & Hwang, 2016; Erbil, 2020). Because the class session is not used for transmitting knowledge to students through lectures, teachers can be involved by providing learning facilities in the form of other learning activities such as discussions, problem-solving proposed by students, direct activities, and guidance. The following are three main principles of the flipped classroom (Safapour et al., 2019): (1) providing opportunities for students to skim the material that will be discussed in class before class meetings, (2) creating incentives for students to prepare before class, and (3) setting up a system to evaluate student learning degrees.

Plant Anatomy course is designed for using flipped classroom. Groups of students are tasked with developing study materials and uploading them on the website of Learning Management System (LMS) elena.unnes.ac.id, two days before the face-to-face lecture. All students study, prepare questions, and upload assignments in LMS. During the face-to-face lecture, the presenter students sort, select, and discuss the relevant problems in their study group. Lecturers act as facilitators and check learning outcomes by conducting specific assessments. However, this nontraditional form also needs to be reoriented in connection with the era of new normal habits. The flipped classroom was acquired with virtual learning to become a virtual flipped classroom (Ismail & Abdulla, 2019; Sangermán-Jiménez et al., 2021; Wade et al., 2021). Face-to-face and hybrid learning are then replaced by online learning (e-learning with Internet and mobile learning).

The learning strategies of flipped learning in much educational research (Aljaser, 2017; El-Senousy & Alquda, 2017; Yao et al., 2017; Zarinabadi & Ebarahimi, 2018; Saglam & Arslan, 2018; Al-Ibrahim, 2019; Ismail, & Abdulla, 2019; Jdaitawi, 2019; Jin & Harp, 2020; Lin & Guder, 2020; Rai et al., 2020; Strelan et al., 2020; Zheng et al., 2020; Gonzalez-Gomez et al., 2022) reported a positive impact on many competencies of students' learning outcomes. Students' achievement improves, becoming independent and better self-regulated learners. An increasing dialogue reflects collaborative work and perceptions of involvement in the learning process. Meta-analysis and bibliometric studies (Akçayır & Akçayır, 2018; Cheng et al., 2019; Al-Shabibi & Al-Ayasra, 2019) obtained results from publication writing that the effect on students' cognitive is significant ($p < 0.001$) and it is recommended that teachers/lecturers use this strategy because it has many positive impacts on learning outcomes.

Self-efficacy is a set of self-perceptions about their abilities and is also related to a more self-regulatory process. Some self-efficacy indicators to help the measurement are 'could,' 'confidence in...' or 'ability to...'. Some research showed strong evidence that high-level self-efficacy is a good predictor of high performance (Alegre, 2014; Nasir & Iqbal, 2019). On the contrary, low self-efficacy can impair performance. A positive correlation also exists between students' achievement and self-efficacy (self-confidence), and students who are given learning with this strategy tend to have a positive attitude and are motivated during the learning process. It is, however, advisable to conduct a study on the reasons behind the lack of clear positive impact of the strategies found in several studies. Likewise, the findings of Palazon-Herrera & Soria-Vílchez (2021), although flipped classrooms had a better effect on self-efficacy, learning environment, and academic commitment, did not affect learning outcomes.

There are only a few studies on using flipped learning as a learning strategy in Indonesia, but they have increased in the last four years. The 2018-2019 publication reports events before the COVID-19 pandemic. The 2021 publication on online learning (Pinontoan et al., 2021) obtained positive effects of applying flipped classrooms with the support of e-modules on statistical learning on students' reasoning abilities and entrepreneurial intentions. As reported by Simanjuntak et al. (2021), the effects of using flipped classrooms in online learning contribute to improvement of mathematical problem-solving skills, especially for students who have self-confidence and there is an interaction between the two. Hasanudin et al. (2020) reported that the elaboration from flipped and google classroom generates asynchronous online learning syntax, which is capable of growing self-development, especially when students take part in Indonesian language learning, students are more skillful in using the four language skills, can write, and are self-awareness for their literacy. A publication relating to research on flipped classrooms implementation strategy in biology learning in secondary and higher education has not been found. Tang et al. (2020) also found that the combined online teaching model with flipped learning improved students' learning, attention, and evaluation of courses.

As previously explained, implementing flipped classrooms can produce various positive attitudes. This positive attitude is increasingly needed in the new normal era of the COVID-19 pandemic. Students must learn to use new habits that have never been done under normal condi-

tions. Self-confidence, collaborative and participatory work, and self-regulated learning students must be maintained and even improved so that student learning achievement does not decrease. Therefore, it is necessary to reveal more implementation strategies for flipped learning, the advantages and disadvantages of learning biology in the new normal era of COVID-19. Based on the tentative model's best practice, this study's ultimate goal is to reconstruct the strategy model of flipped classrooms for online biology learning.

METHODS

This research is collaborative with one similar main theme, flipped learning for biology learning, between lecturers and students, which takes place in three sequences (Study 1-3) in three places involved (1) Biology, UNNES, (2) SMA N 4 Pekalongan, and (3) SMA N 1 Karangayung, Demak. Each stage was done with a different research approach following the data expected to support reconstructing a new strategy model of biology learning flipped classroom.

Study 1: The research was designed with a qualitative approach (Mohajan, 2018) to investigate the effectiveness of the strategy model of the flipped classroom. The object of the course was Plant Anatomy before and the beginning of the new habits of the COVID-19 pandemic. The research is conducted in the even semester (2019/2020) and odd semester (2020/2021). The lectures were designed using flipped classrooms and administered at LMS elena.unnes.ac.id. The research employed the case study method of presentations for online lectures. Several case aspects of the subject and object of learning were defined and coded for their appearance in the learning process. Members of the study group were given structured assignment activities to study the material and were grouped into presenters, discussants, and discussion members. The presenter group was required to prepare papers and media and load them in LMS two days before face-to-face learning in class (pre-pandemic era) or face-to-face using Zoom meeting video conferencing platform and Google Meet (in the pandemic era), synchronously or synchronous discussions on LMS. During the synchronous phase, the discussants responded and got discussions. Learning media is compared in appearance between pre-pandemic and during the pandemic using observation and document techniques. The subject of prospective teachers investigated how to use the media to explain and discuss during the synchronous phase. The data were taken from

the display of learning media and how to use it in the learning process, and the value of participation during semester learning ($A \geq 86$, $86 > AB > 80$, $80 \geq B > 70$, and $F \leq 70$). Data were analyzed descriptively.

Study 2: The research aims to test the effectiveness of the tentative model flipped classroom as designed in the Plant Anatomy course by considering the findings of study 1. The research was conducted at SMA N 4 Pekalongan in the odd Semester of the 2020/2021 Academic Year. The sampling for the experimental and control classes used the purposive sampling technique after it was revealed that the population was homogeneous. The experimental class was applied to learn flipped classrooms through Microsoft Teams with asynchronous self-learning and synchronous virtual classroom during class hours. The control class was applied to learn non-flipped by method video conferencing and assignment. The data were the achievement from pretest and posttest results with three-tier test multiple-choice questions. Such questions could reveal which students already understand concepts, do not understand concepts, do not understand concepts, and misconceptions (Cheung & Yang, 2018), but in this study, the data were transformed into only understanding concepts and not understanding concepts. The scale of students' self-efficacy before and after learning used an instrument similar to the instrument developed by Sunaryo (2017). The Mann-Whitney test analyzed the students' achievement data because the prerequisite test for parametric statistics did not meet the requirement. Students' self-efficacy is categorized into seven categories: very high (always can do) to very low (never can do).

Study 3: This step was done in a research and development approach based on valuable evidence from studies 1 and 2. Biology material content, syllabus, lesson plans, worksheets, and assessment instruments were developed to obtain the models of flipped e-learning classrooms in the new era of the COVID-19 pandemic. Learning tools (syllabus, lesson plans, student worksheets, learning media, evaluation instruments) have received validation evidence from experts. The validation of the assessment instrument was also carried out empirically. The average item difficulty level is 0.53, and the discrimination index is 0.54. The estimated reliability of the measured test was 0.842 with the Spearman-Brown formula.

Further research was carried out at SMA N 1 Karangayung, Demak, in the even semester of the 2020/2021 academic year. The data collection method used observation with a question-

naire instrument on the functioning of learning devices. Learning is undergone according to the ten steps of peer instruction flipped learning to describe the steps of scientific literacy-based learning. Data were analyzed descriptively. Based on the data, a model reconstruction is carried out, and the results are presented in a flowchart.

RESULTS AND DISCUSSION

Under the research design, the research results will be described from the results of studies 1, 2, and 3.

Study 1. Various findings were coded, and the data exposure is shown in Table 1. One advantage of the COVID-19 pandemic is the accelerated skills of prospective teachers to use virtual face-to-face media by teleconference media. It had never been practiced before the pandemic.

The skills of prospective teachers in making PowerPoints refer to the indicators of making presentations and creating animation effects not seen during the implementation of the flipped class. It means that relating to the literacy of creating more complex (multimedia) learning media needs to be a concern for prospective teachers. It is important to increase students' artistic creativity through the practice of media creation.

The increase in the percentage of students who get participation scores occurs during online learning (Figure 1). Students are more actively involved in case of discussions according to the topic. It is mostly because students reviewed the papers and PowerPoint prepared earlier by the presenter from the group two days before the discussion. Lecturers optimized learning time with structured assignment activities.

Table 1. Case Aspects Coded in the Analysis

Case Aspect	Coded Data Serving
Looks and looks good offline and online	
Attitude considerations	the attractiveness of the material in the media motivating users
Learning	suitability of the material in the media with the characteristics of the user suitability of learning strategies PowerPoint media use interactivity
Content Serving	material depth material order the truth of the material material description 2 Key Concepts and Theories giving examples language accuracy with grammar language clarity of the language used
Media/multimedia display	language suitability with the target user level font selection accuracy easy menu selection simple and attractive layout selection match the color composition/make a simple and easy-to-read background suitability of <i>Screen design</i> with users formatting text neatly and proportionately attractive image format Robustness
Appears when offline but not when online	

Case Aspect	Coded Data Serving
	Not visible when offline but visible when online
Learning	additional skills in using media Note: skills in using digital media seem to improve online. Students gain new skills using meeting media in the form of zoom meetings and google meet, recognize the use of navigation buttons on the two interactive virtual face-to-face learning media
	Not/not yet visible when offline and online
Content Serving	up-to-date
Media Display	giving shape effects to text/images (shape effects) text animation animated images that are unique but do not distract students bringing out artistic creativity adding sound effect use of multimedia (making audio-video media) interactive display media

The value of student participation during the semester learning is assessed, and the data were shown in Figure 1.

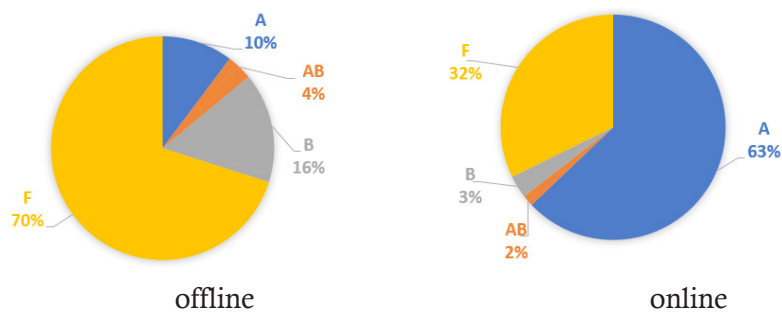


Figure 1. Percentage of Student Participation Scores on the Implementation of Flipped Classroom Registered at *elena.unnes.ac.id*

Study 2. Students' Conceptual Understanding. The group of students who understand the concept and do not understand the concept between the experimental and control class can be explained in Figure 2.

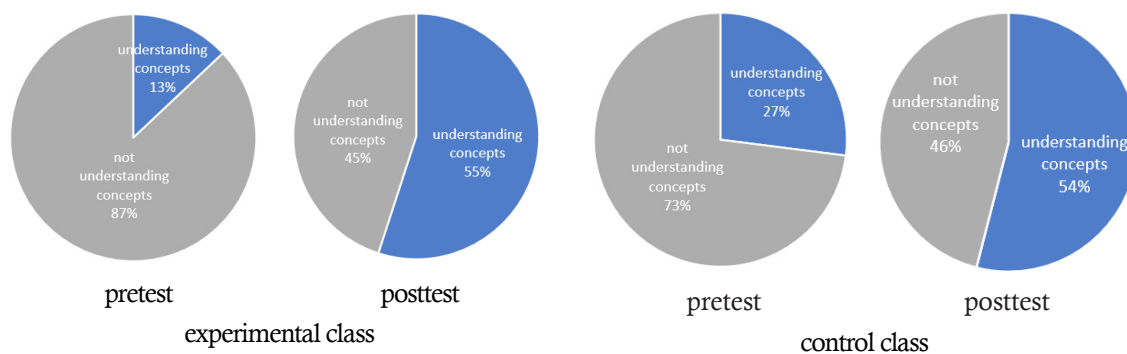


Figure 2. Understanding the Concept between the Experimental Class and the Control Class

Figure 2 reveals that students' concept understanding rises by 42% in experimental and 27% in control classes. This finding supports the better effect on experimental classes conducted in flipped classrooms.

The proportion of students' self-efficacy levels in every aspect of the experimental and control classes before and after learning can be seen in Figure 3. Based on the data in Figure 3, it is revealed that the increase in self-efficacy occurred in students categorized as moderate (occasionally

can do) to quite high (usually can do) in the experimental group. Students with a high level of self-efficacy (almost always can do) remain in the same category. Meanwhile, in the control group, the moderate self-efficacy level (occasionally can do) was still higher.

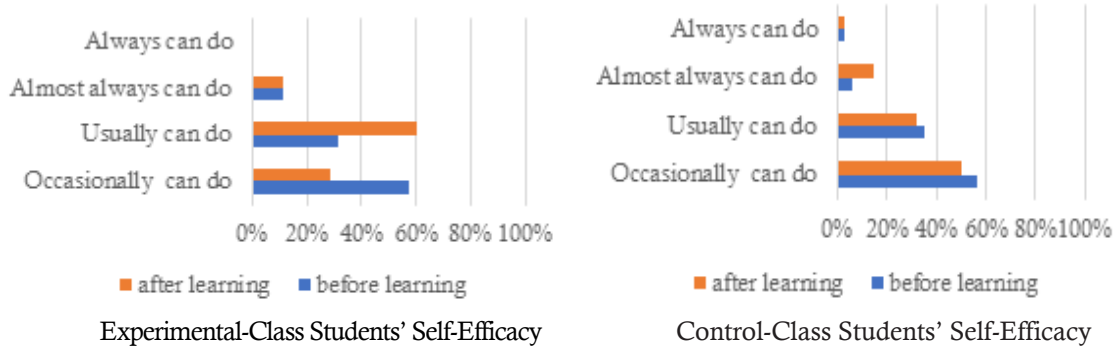


Figure 3. Percentage of Self-Efficacy Levels According to Categories Before and After Learning

Table 2 deepens these findings, revealing that the self-efficacy dimensions more influenced by flipped classrooms are magnitude and strength. The high category group (almost always can do) increased by 17.15%. This dimension relates to the task's difficulty when the individual feels capable of doing it. This has implications for

choosing the proper behavior. The dimension of strength was also affected, although not as large as the dimension of magnitude. The self-efficacy of students from the control group tended to remain before and after learning. The increase in some categories is only one digit.

Table 2. The proportion of Student Count According to Each Level of Self-Efficacy Dimension

Dimension	Indicator	Category	Students Counts Proportion (%)			
			Experiment		Control	
			before	after	before	after
Magnitude	Feeling confident that you can complete the task	Always	-	-	-	2.94
		Almost always	5.71	22.86	8.82	11.76
		Usually	37.14	48.57	55.88	58.82
		Occasionally	45.71	25.71	29.41	20.59
		Usually not	11.43	2.86	5.88	5.88
		Almost always not	-	-	-	-
	Being able to do the item for different difficulty levels	Always	-	-	2.94	2.94
		Almost always	-	-	5.88	5.88
		Usually	34.29	40.00	17.65	20.59
		Occasionally	48.57	45.71	44.12	41.18
		Usually not	17.14	14.29	8.82	8.82
		Almost always not	-	-	20.59	20.59
		Always not	-	-	-	-

Dimension	Indicator	Category	Students Counts Proportion (%)			
			Experiment		Control	
			before	after	before	after
Generality	Dealing with various situations with positive manner	Always	2.86	2.86	-	-
		Almost always	5.71	8.57	14.71	14.71
		Usually	57.14	57.14	14.71	14.71
		Occasionally	34.29	31.43	61.76	67.65
		Usually not	-	-	8.82	2.94
		Almost always not	-	-	-	-
		Always not	-	-	-	-
	Experience as a guide to solve problem	Always	-	-	8.82	8.82
		Almost always	40.00	40.00	26.47	26.47
		Usually	54.29	54.29	58.82	58.82
		Occasionally	5.71	5.71	5.88	5.88
		Usually not	-	-	-	-
		Almost always not	-	-	-	-
		Always not	-	-	-	-
Strength	Believing and knowing of having advantages to solve problems	Always	-	5.71	2.94	2.94
		Almost always	25.71	22.86	20.59	20.59
		Usually	60.00	60.00	44.12	50.00
		Occasionally	14.29	11.43	29.41	26.47
		Usually not	-	-	2.94	0.00
		Almost always not	-	-	-	-
		Always not	-	-	-	-
	Commitment to solve problems	Always	2.86	2.86	2.94	5.88
		Almost always	14.29	20.00	14.71	20.59
		Usually	60.00	60.00	47.06	44.12
		Occasionally	20.00	14.29	35.29	29.41
		Usually not	2.86	2.86	-	-
		Almost always not	-	-	-	-
		Always not	-	-	-	-

Study 3. Learning devices used in learning were generally well functioning, as evidenced by a good performance assessment after learning by the informant. Observations during learning showed that students actively observed video shows and discussed and analyzed scientific articles in groups. Student-centered learning activities can facilitate the construction of knowledge. The functioning of the learning devices disclosed by the informants can be described as follows: a. Syllabus. The syllabus was adapted to the model of the e-flipped classroom in the form of asynchronous and synchronous learning. The syllabus has components that align with current conditions and follow existing developments; b. Learning Plan and Implementation. Learning begins asynchro-

nously independently anytime and anywhere using Google Classroom and is continued by synchronous learning through Zoom Cloud Meeting. After the synchronous one is done, the learning is resumed automatically by collaborative asynchronous learning. Such pattern rotation can train lower-order thinking skills into higher-order thinking skills and help understand the application of the material in everyday life, as well as scientific and technological literacy. Such a pattern can also force students to inevitably study and prepare problems and solutions before discussing them with the teacher. Google classroom is rightly chosen as an asynchronous learning platform. Teachers can monitor learning activities, set topics and assignments, and provide feedback and assessments. Collaborative asynchronous learning to analyze

scientific articles makes students understand the application of the materials about life for problem-solving and decision-making, so their scientific literacy skills are trained. Zoom cloud meeting platform is used for synchronous learning because an e-flipped classroom with peer instruction type needs the formation of study groups that the breakout room menu can facilitate on the platform; c. Student Worksheets and Learning Media. Worksheets and learning media uploaded on Google classroom can be used as supplementary materials when students learn Biology asynchronously or synchronously. Worksheets attached by video links connected to YouTube and problems or exercises functioned as materials for direct discussion with peer instruction at a synchronous session. Student informants mentioned that the worksheets were communicative and structured, so they highly recommended using student worksheet models in learning during the COVID-19 pandemic. Physiological processes can be concreted through visualization and repeated scrutiny. Weaknesses are found in learning media that are not designed by the teacher but are only taken from YouTube; d. Assessment Instrument. The assessment instrument refers to the scientific literacy ability, stating that students are easy to understand from the language and context. Informants stated that the questions were made with varying difficulty levels and HOTS cognitive levels. Items at the interpretive

analysis level are more complex than at the evaluative level. Based the advantage of the assessment instrument, it was positively appreciated by the informants. Difficult items challenge students to think. At the same time, they can serve as a source of gaining new knowledge because some items provide new information.

The implementation steps of flipped classrooms based on the results of the development analysis of the syllabus, lesson plans, worksheets, and evaluation instruments after getting expert validation can be illustrated in Figure 4. It, then, is called referred to as the flipped classroom virtual strategy model. Implementing these steps has made students become regulators of learning for themselves. Teacher and student informants gave a positive impression of the worksheet. This is reflected in the given suggestions and responses. Students generally revealed that it could motivate their learning. The discussed material is linked to YouTube, which can assist students in understanding the material when it carries out distance learning. Students suggest that the worksheet writing should be more thorough so that it is easy for readers to understand, the links should not use all English, and add a few pictures in the worksheet so that readers are not bored.

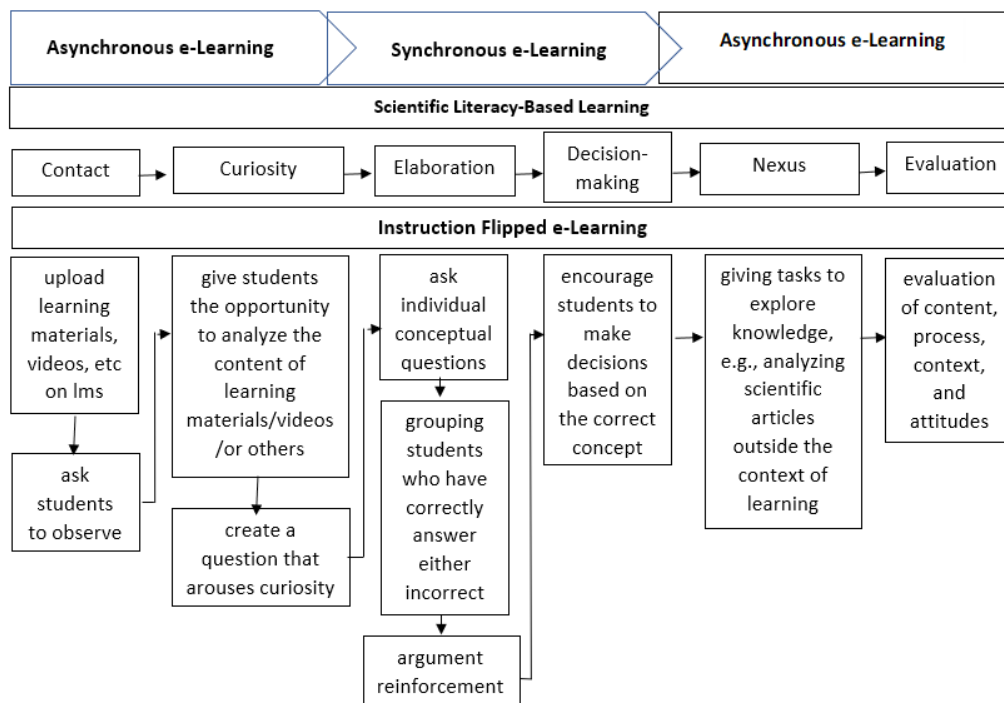


Figure 4. Reconstructed Strategy Model of Virtual Flipped Classroom for Biology Learning

Designing innovative pedagogy with “green pedagogy” and an innovative mindset in the future will be increasingly needed. According to Brinia and Davim (2020), innovative pedagogy is based on innovative design thinking, art-based practice, digital transformation, and entrepreneurship. New pedagogical methods and educational solutions are developed to support student learning, significantly increasing social responsibility, motivation, and commitment and enhancing creativity and innovation. Innovation through strategy implementation of the virtual flipped classrooms has been proven to bring positive things from student learning. The positive thing that can be obtained from the studies is that it can foster an attitude of being a regulator for their learning, increase self-efficacy, increase the number of students who understand concepts compared to non-flipped /conventional strategies, increase literacy on the use of learning media, especially during the new normal of the COVID-19 pandemic (Hsiao et al., 2019; Hosseini et al., 2020)

Based on meta-analysis studies by Cheng et al. (2019), the usage of flipped classrooms as a learning strategy and its success are moderated by the kinds of subjects. Biological content contains the study of the structure and processes within the structure. Sometimes, the phenomena found in living things must be studied through prolonged and repeated observations. Therefore, this study chose the type of peer instruction that allows for step flexibility between synchronous and asynchronous learning. Akçayır & Akçayır (2018) explain that acquiring peer instruction in a flipped classroom allows collaborative problem-solving and cooperative working to complete a project outside the classroom with technical assistance. Online synchronous learning is not just moving face-to-face learning in the classroom. Mishra et al. (2020) stated that virtual classroom experience, patience, empathy, concern for students, excellent presentation skills by directing to a given topic point, and handling of learning media available with easy-to-use features are additional skills found to manage the online teaching process. The findings of study 1 provide a meaningful provision for study 2. In study 2, the researchers designed a better learning scenario and especially media presentation so that it had implications for improving student learning outcomes and self-efficacy. Flipped classroom on learning activities significantly improves students' self-efficacy compared to conventional models and has a good influence on students' understanding of concepts (Al-Shabibi & Al-Ayasra, 2019; Pala-

zon-Herrera & Soria-Vílchez, 2021). Learners get an interactive learning environment that supports their independent learning increase (Al-Shabibi & Al-Ayasra, 2019; Lin & Guder, 2020). The flipped classroom strategy could also promote self-regulated learning and enhance students' social connectedness (Jdaitawi, 2019; Zheng & Zhang, 2020; Wang & Chen, 2020). The findings of study 2 support this opinion.

The flipped strategy model resulted from the reconstruction in Study 3 with asynchronous – synchronous – asynchronous sequences practiced with ten steps of flipped peer instruction to describe the syntax of scientific literacy-based learning is appreciated according to biology learning during the COVID-19 pandemic. The successful use of study 2 proves that the series of phases can increase the proportion of students who understand concepts and self-efficacy compared to conventional strategies. The advantages of using this phase were also demonstrated in Study 1. Prospective teachers can still maintain their presentation performance during online learning and even gain additional skills when using presentation media (PowerPoint) which must be presented through zoom meetings or google meet. Although it was not investigated whether the variables of study materials and subjects moderated the success of flipped classrooms in the new normal era, it is proven to provide positive evidence of learning success. These results support previous research from Aljaser (2017); El-Senousy & Alquda (2017); Yao et al. (2017); Al-Ibrahim (2019); Al-Shabibi & Al-Ayasra (2019); Ismail & Abdulla (2019); Lin & Guder (2020); Rai et al. (2020). Learning in groups applied to the reconstructed model is either used in a virtual flipped classroom as Zarrinabadi & Ebrahimi (2018) or succeeded in proving a virtual flipped learning group collaboration increase.

Al-Shabibi & Al-Ayasra (2019) suggest conducting a study of the reasons behind the lack of a clear positive impact of the strategy in several studies. Study 3 showed that students advised on the worksheet, which became one of the learning resources. For students, this is their success in becoming a regulator as autonomous learners, but for teachers, it is a weakness of the scenarios and learning tools. The results of study 1 also show that there are indicators of learning media that cannot/have not been met for strategy implementation of flipped classrooms in both online and offline learning. It may not be able to see the effect or moderate the optimal learning success in the Plant Anatomy course. If it is fulfilled, it may be possible to achieve the state produ-

ced by El-Senousy & Alquda (2017), Akingbemisilu (2017), and Gonzalez-Gomez et al. (2022). Therefore, Zheng et al. (2020) suggest combining flipped classrooms with mind mapping, which is proven effective in improving learning outcomes and self-efficacy compared to using a single mind mapping strategy. Jin & Harp (2020) even innovated the flipped classroom with flipped team-based learning to improve the TPACK of teacher candidates, attitudes, self-efficacy, and perceptions of teamwork. Currently, this strategy is being implemented in online lectures in the Biology Learning Evaluation and Educational Research Methods and Techniques at the Biology Education Study Program of UNNES to create collaborative and participatory classes according to the main performance indicators of state universities

CONCLUSION

The developed scientific literacy-based virtual learning using flipped classroom strategy is proven to increase skills in the use of information technology for the benefit of learning and student participation in learning. The flipped strategy has proven to have a better effect on learning outcomes, as indicated by a more significant increase in students who understand concepts in the experimental class. Students' self-efficacy increases in the indicator of the degree of task difficulty when individuals feel they can do it, especially in the "occasionally can do" category group to "almost always can do." The asynchronous-synchronous-asynchronous strategy model in the instruction of flipped e-learning classrooms was well appreciated by validators, teachers, and students because it functions well according to the syntax of scientific literacy-based learning. The developed virtual flipped classroom model is an ideal model for biology learning. Further research will be very interesting if flipped learning is innovated into flipped team-based project learning.

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