

Research Article

Online Quantitative Literacy-Based Biology Learning towards Students' Self-Efficacy

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Abstract.

Quantitative literacy is an important skill for biology students. During COVID-19, students had to adapt to several changes, including shifting from offline to online classes. However, not all biology content can be taught easily, especially online. Therefore, students need self-efficacy abilities. Self-efficacy was important for students to be able to make a plan for their learning. This research aimed to describe students' self-efficacy to continue their online biology learning during COVID-19, based on their quantitative literacy skills. This study used 20-item questionnaires with four choices of statements. The biology topic chosen was plant anatomy. This research measured the score of 82 first-year college students' self-efficacy from three aspects - magnitude, strength, and generality. Data were analyzed using descriptive statistics to measure the mean, the highest, and the lowest students' self-efficacy scores. The result showed that the average score of students' self-efficacy was 2.72, which means students' self-efficacy was in the moderate category. All three aspects were also in the moderate category, with the strength aspect score being the highest at 2.76 and the magnitude aspect score being the lowest at 2.66. Based on the number of participants' level of self-efficacy, 3% of students were in the high category, 96% were in the moderate category, and 1% were in the low category. The result showed that most of the students in this research have a moderate level of self-efficacy in online biology learning, based on quantitative literacy. This means that most of the students still must develop their self-efficacy skills to learn online quantitative lessons in biology successfully. The results also suggested that it is essential to teach students how to manage their learning behavior through the development of self-efficacy to succeed in online quantitative lessons in biology learning in the future.

Keywords: literacy, online class, self-efficacy

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1. INTRODUCTION

Quantitative literacy, also known as numerical literacy or quantitative reasoning, is a person's ability to think logically to articulate data in the form of numbers [1]. Quantitative literacy is not limited to statistics or mathematics courses only but also it should be applied to every course material [2]. The Association of American Colleges and Universities (AACU) formally describes quantitative reasoning as “the habit of mind, competency, and comfort in working with numerical data” [3]. Someone with solid quantitative literacy skills can think and solve various life problems in various situations and contexts [2, 4]. Furthermore, someone with good quantitative literacy will become more independent learners, can manage their time efficiently, and increase their confidence in technological skills [5]. Referring to the AACU, there are several indicators of quantitative literacy, including interpretation, representation, calculation, assumption, and communication [3]. Those indicators must be translated verbally, graphically, and symbolically [6].

Attention and support for the development of numerical literacy are increasing in undergraduate biology education [5, 7]. A concern on quantitative aspects of biology education is an indicator of mathematics and statistics integration to support the modern approach to biology [5]. It is clear that to achieve the goals of current modern biology, undergraduate biology students must be able to integrate and utilise quantitative skills in a variety of biological contexts [5, 8]. Students must have an ability to explain how a given set of numbers leads to assertions. The ability to learn to reason like a biologist is a highly developed skill that requires practice and feedback over time [1]. Furthermore, biology students must be able to design experiments, determine the correct data collection methods, and apply appropriate quantitative analysis to support the validity of their research [5, 9]. Therefore, quantitative literacy is an essential competency that must be concerned to become the priority in improving the undergraduate biology curriculum [10].

Most biology content in Indonesia is described as qualitative content. This is because mathematics and biology are taught independently. Thus, the student's quantitative literacy skills are low [11]. One of the biology courses that is quite difficult to quantify is plant anatomy. Currently, plant anatomy courses are mainly analyzed from a qualitative point of view only [12]. In fact, plant anatomy courses have various opportunities that can hone students' quantitative literacy skills, such as cell size and density, object magnification, and three-dimensional modelling [11, 12]. Those skills can be studied well if students have good quantitative literacy skills [12]. The course will be easier to learn

in a laboratory with adequate equipment. However, since the Covid-19 pandemic hit, learning has been shifted online.

The teaching of quantitative-based biology learning becomes more challenging because it must be carried out online at home [13]. Students become unable to discuss directly with friends. In addition, lecturers find it difficult to provide feedback directly to students. Online learning requires various efforts to meet the criteria that can at least match the hands-on practical experience in the laboratory [14]. One thing to be noticed is that online learning does not provide practical skills to the students. This is because online learning at home lacks the equipment compared to the actual laboratory. Usually, in plant anatomy courses, students can measure, count, and compare microscopic objects hands-on with adequate measuring tools. However, due to distance learning, students are only given instructions and simulations of how to do the measurement. This circumstance tends to reduce the potency of developing student quantitative literacy skills.

Despite reducing students' ability to increase quantitative literacy skills, online learning could improve the learning outcomes because it is more student-centered [15]. Therefore, to achieve this goal, students must have good self-efficacy. Bandura, describes self-efficacy as "someone believes in their capabilities to produce given attainments [16]. Students who have good self-efficacy tend to work effectively, complete many tasks better, and anticipate difficulties that arise during learning [17, 18]. This will result in better academic achievement because students with good self-efficacy tend to have a good learning motivation that will affect their learning performance [19]. In traditional learning, score, goals orientation, and effort regulation are highly contributed to students' learning outcome [20]. But, in online learning, students' confidence to understand and succeed in the course has a great impact. This is because, perhaps, online learning is instruction task-based and might motivate students with task orientation [20]. The research about analyzing students' learning behaviour in an online quantitative literacy-based in biology learning environment still has low attention. Therefore, this study aims to find out how the self-efficacy abilities of undergraduate biology students in facing various challenges in plant anatomy online quantitative literacy-based learning.

2. RESEARCH METHOD

This type of research is descriptive research, and the data was collected through a survey method. The research subject is 82 first-year undergraduate college students

attending plant anatomy courses in one of the educational colleges in Indonesia. This research was conducted in a plant anatomy course already held for eight meetings. The students were taught with quantitative literacy-based learning. They were asked to calibrate the microscope lens, measure some features of the plant cells, measure the thickness of the cell plant wall, and count the plant cell density virtually through an online meeting platform. They learned by observing online pictures and videos, online worksheets, and online discussions. Then, the students were asked to answer the questionnaire, which rates students' self-efficacy in online quantitative literacy-based plant anatomy learning. The questionnaire contains 18 statements with 4 scales from 1 strongly disagree to 4 strongly agree. The questionnaire covers three aspects of self-efficacy as stated in Table 1. The three aspects are based on Bandura's self-efficacy aspects [18]. The reliability score of overall instruments is $\alpha=0,834$. The research data is analyzed through descriptive statistics to measure the mean, highest, and lowest score of students' self-efficacy in the online quantitative-based plant anatomy course.

TABLE 1: Student's self-efficacy aspects from Bandura.

No	Self-Efficacy Aspects	Indicator	Total Item
1	Magnitude	Confident to succeed in the task given	5
2	Strength	Able to complete the task under certain order/conditions	7
3	Generality	Shows a positive attitude to complete the task	6

The students' self-efficacy data were then categorized into three criteria. Students categorized as having low self-efficacy if score $< X - SD$; moderate self-efficacy if $X - SD \leq \text{score} \leq X + SD$; high self-efficacy if score $\geq X + SD$. The categorization is stated in Table 2.

TABLE 2: Self-efficacy levels.

Level	Score
Low	<2.2
Moderate	$2.2-3.3$
High	>3.3

3. RESULT AND DISCUSSION

The result of students' self-efficacy in online quantitative literacy based on plant anatomy courses can be seen in Table 3. The overall mean student self-efficacy score is 2.72.

It shows that students' self-efficacy is in the moderate category. There is no significant difference between the three aspects. The highest aspect is strength with a score of 2.76, while the lowest aspect is magnitude with a score of 2.66.

TABLE 3: Undergraduate students' self-efficacy level on online quantitative literacy-based in plant anatomy course.

No	Self-Efficacy Aspects	Mean	SD	Level Category
1	Magnitude	2.66	0.515	Moderate
2	Strength	2.76	0.537	Moderate
3	Generality	2.72	0.581	Moderate

SD= Standard Deviation

Students' response to the self-efficacy statement is stated in Table 4. The results showed that in online learning, most students had moderate self-efficacy. The same result was also similar to another research that stated students have moderate level of self-efficacy in an online learning environment [21]. The average first-year students still have to adapt to this online learning environment. Moreover, students are asked to think abstractly to imagine how quantitative processes such as microscope calibration and measurement of several cell components are carried out. Some students have not been able to construct these processes because students never carried out the activity directly in the lab before. So, they are not fully confident that they can learn this quantitative-based plant anatomy course well. There is a tendency that undergraduate students who study in the online quantitative-based plant anatomy course, still need guidance on how to manage or increase their self-efficacy ability. The development of self-efficacy is not only based on the prior abilities but also influenced by experience, feedback, and support from others [16]. In order to support the undergraduates, this course has two practicum assistants who provide help for the students about the course. That is because a first-year undergraduate student still depends on that kind of feedback whether it is from a lecturer, practicum assistants, or another friend.

The highest score is the strength aspect. This aspect shows that students show good confidence in completing the assignment in online quantitative literacy-based biology learning. Another similar result also states that the strength aspect has a high score in an online learning environment [22, 23]. Even though learning is held virtually, students believe they can finish the assignments because online learning makes it easier to find sources that can help them complete assignments. The given deadlines, open online peer discussion, and a chance to browse the internet while learning increase students' confidence to complete the task. In addition, there are also similar practicum results

from the past year from the seniors on the same material so that students can learn from the seniors' papers.

The statement with the highest mean score was obtained from the strength aspect, which states, "I try to communicate with my friends to solve problems in online quantitative literacy-based plant anatomy course", with a mean score of 3.4 (SD = 0.52). This statement was responded by 41% of students who responded strongly agree, 58% agree, and 1% of students disagree. This shows that online discussion is one of the best ways for students to face problems in online quantitative literacy-based plant anatomy course learning. This data shows the same result with a similar statement: "I try to communicate with friends to solve problems in the online quantitative-based plant anatomy course" [23]. Discussion is one of the best ways to exchange ideas with other people. During the discussion, one student tends to be the knower and the other is an asker who will actively ask questions. This will improve students' critical thinking skills because students can implement their knowledge actively through an online discussion [21]. In addition, the discussion in online biology learning based on quantitative literacy led students to research deeper to answer the questions from their friends. For the knower, he must first understand the topic that he will answer to his friend. Then he must be able to translate the information into simple language. On the other hand, the asker will easily understand the information because the information he gets has been rephrased into an easy-to-understand language.

On the other hand, the lowest mean score was obtained from the statement "I feel less confident to learn in the online quantitative-based plant anatomy course", with a mean score of 2.22 (SD = 0.59). This statement was responded to by 9% of students who strongly agree, 61% of students agree, and 30% of students disagree with the statement. This shows that more than half of students feel less confident being able to follow quantitative-based learning taught by lecturers. The students feel less confident because they do not have a chance to apply quantitative literacy-based learning directly. They do not see the actual form of the cell, and they also do not have an opportunity to interact with the microscope. Another reason is that the students do not have direct feedback about whether the measurement is correct or not if later they do it on a plant's actual cell measurement.

There are two students categorized as having high self-efficacy and one student having low self-efficacy. Students who are categorized as having high self-efficacy show a very positive response because they strongly agree on most aspects of magnitude. Their responses show that they have a positive attitude and self-confidence to complete the given task. The one categorized as having low self-efficacy expresses a

TABLE 4: The recapitulations of student response on self-efficacy in the online quantitative-based plant anatomy course.

Self-Efficacy Aspects	Statement	Strongly Disagree	Disagree	Agree	Strongly Agree	Mean	SD
Magnitude	I believe that I can get a good score in the online quantitative-based plant anatomy course.	-	13	68	1	2.85	0.39
	I believe that I can learn the important concept in the online quantitative-based plant anatomy course.	0	30	49	3	2.67	0.55
	I can finish all the materials that are taught in the online quantitative-based plant anatomy course.	2	51	29	0	2.33	0.52
	I am confident to complete all the assignments given in the online quantitative-based plant anatomy course	1	24	53	4	2.73	0.57
	I believe that I can master all of the competencies that are asked in the online quantitative-based plant anatomy course	0	27	51	4	2.72	0.55
Strength	I can decide the correct strategies to complete the assignments in the online quantitative-based plant anatomy course	0	29	51	2	2.67	0.52
	*I fail to find an alternative way when I am “stuck” in the online quantitative-based plant anatomy course	2	40	36	4	2.49	0.63
	*If the lecturer taught methods in the online quantitative-based plant anatomy course, I can’t make that method more effective and efficient.	1	46	34	1	2.57	0.55
	I try to communicate with friends to solve problems in the online quantitative-based plant anatomy course	0	1	47	34	3.40	0.52
	I train my ability in the online quantitative-based plant anatomy course regularly.	0	24	55	3	2.74	0.52
	I can utilize an example or search for another resource to solve problems in the online quantitative-based plant anatomy course	0	6	66	10	3.05	0.44
	*I feel so hard to manage time in the online quantitative-based plant anatomy course	1	33	45	3	2.39	0.58

disagreement in all magnitudes. This shows that students with low self-efficacy tend

TABLE 4: Continued.

Self-Efficacy Aspects	Statement	Strongly Disagree	Disagree	Agree	Strongly Agree	Mean	SD
Generality	*I am less interested to learn in the online quantitative-based plant anatomy course	7	56	18	1	2.84	0.58
	I believe that I can understand all the course in the online quantitative-based plant anatomy course even though it is very hard	2	43	35	2	2.45	0.59
	I believe that I can put my best ability to learn every material in the online quantitative-based plant anatomy course	0	14	57	11	2.96	0.55
	*I feel less confident to learn in the online quantitative-based plant anatomy course	0	25	50	7	2.22	0.59
	I feel motivated to solve all hard problems or questions in the online quantitative-based plant anatomy course	0	22	53	7	2.82	0.57
	*I feel desperate to complete the online quantitative-based plant anatomy course.	15	52	15	0	3.00	0.61

*Negative Items, SD= Standard Deviation

to underestimate themselves and limit their self-efficacy ability to increase their self-efficacy [24]. That student also showed his disagreement response to all statements from the generality aspect. This aspect is closely related to the behavioural element, which describes the sense of self-confidence to succeed in an online quantitative literacy-based in plant anatomy course. Based on the responses, students with low self-efficacy show low self-confidence and interest in succeeding in an online quantitative literacy-based plant anatomy course.

While there was a similar average score from the three self-efficacy aspects, this research had several limitations, and these limitations could provide ideas for future study. This study had limited generalizability due to the respondent being just from a plant anatomy course. So the result might vary from another online biology course. Further research could be done from another quantitative literacy-based biology undergraduate course to gain a broad and holistic perspective on student self-efficacy in a quantitative-based online learning environment. As preliminary research, another limitation of this research was this research only collected student self-efficacy data in a half-semester. It would be better if the future research compares the pre-score of

self-efficacy at the beginning of the semester, then in the half-semester, and the post-score of self-efficacy in the last semester. If there was only a one-time assessment, there was a tendency of ceiling or floor effect that the students didn't respond to the statement clearly because they rated them higher or lower just for that session only [3]. Further research also can have better results if it investigates the correlation between student self-efficacy with student assessment performance. So it will reveal the effects of students' self-efficacy on their learning performance in an online quantitative literacy-based plant anatomy course.

4. CONCLUSION

With all the limitations due to online learning courses, student self-efficacy is important to monitor students' learning success. Students cannot continue to rely on the direction of the lecturer. Students need to be confident and creative to be successful in the subjects studied. This research shows that most students have moderate levels of self-efficacy in the online quantitative-based plant anatomy course. The highest self-efficacy mean score is the strength aspect. Online discussion is one of the most frequently used ways when students face difficulties in the online quantitative-based plant anatomy course. It also shows that students' confidence in the online quantitative-based plant anatomy course was low because in online learning students were not able to provide actual practical skills. Therefore, lecturers have a role to teach students to be more confident and creative in online learning environments. Further research can be conducted to investigate whether the level of student self-efficacy in the online quantitative-based plant anatomy course is related to their academic performance. This can strengthen the reason that students are more aware of self-efficacy in learning.

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