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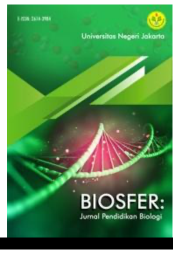

Numerical literacy profile of biology students in plant physiology practicum and level of conceptual change

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ABSTRACT

Plant physiology is material that is considered difficult, and studying it requires adequate numeracy literacy, especially in practicums. Thus, it is necessary to reveal the student's numeracy literacy profile and the level of conceptual change before and after the practicum. This study used a pre-experimental design with a pre-test and post-test group. The pre-test regarding numeracy literacy, which refers to the Minimum Competency Assessment, is given to Biology Education Department students who are contracting the Plant Physiology course in the odd semester 2022/2023, conducted before practicum about accumulation of mineral nutrients in plant cells, nutrient culture, water potential, and osmotic potential. After each practicum, students are assigned to answer response questions, and it ends with a post-test. The results showed that there was an increase in student numerical literacy from the very low category (42.7) into the moderate category (62.1) with level of conceptual change in the construction and N-gain in low categories. Although it has the potential to improve students' numeracy literacy, the Plant Physiology practicum needs to be improved, for example, by involving practical students in preparing substances and strengthening the lecturers in their responses.

INTRODUCTION

Until now, plant physiology is biology material that is considered difficult (Çimer, 2012); Vila & Sanz, 2012; Malińska et al., 2016; Mumuni et al., 2017), so efforts are needed to overcome it, for example through various improvements in learning (Afandi, 2014; Diana, 2017a, 2017b, 2019; Sih & Martini, 2019) and development of teaching materials (Ningrum et al., 2014). Studying plant physiology material cannot be separated from the use of mathematical concepts, so adequate numeracy literacy is required. Of all these studies, it is rare to reveal mastery of numerical literacy related to plant physiology material, especially in terms of the level of conceptual change. Several studies have been conducted regarding quantitative literacy in the field of biological sciences, namely, among other things, plant anatomy (Nuraeni et al., 2015), coordination system (Harianto et al., 2017), genetics (Andriani et al., 2022), and on environmental change material (Febrianti et al., 2021). Numeracy Literacy can be defined as the ability to think using concepts, procedures, facts, and mathematical tools to solve daily problems in various types of contexts that are relevant as Indonesian citizens and global citizens (*Pusat Asesmen dan Pembelajaran*, 2020). This is in accordance with several definitions of numeracy summarized by Luterbach & Morris (2012) that numeracy is the ability, confidence and willingness to engage with quantitative or spatial information to make informed decisions in all aspects of daily living. Numeracy is a foundation for continuous learning and provides individuals with the ability to achieve personal goals, develop knowledge and potential, and participate fully in society. High literacy and numeracy skills are associated with personal, social, and economic well-being (EU Skills Panorama, 2015). People with higher literacy skills are more likely to be mentally and physically healthy, live longer, be more productive and more satisfied at work, and less likely to live in poverty, be unemployed or economically inactive, and commit fewer crimes. Therefore, numeracy skills are not just about mastering mathematical principles but also about being able to apply them in everyday situations. Having good numeracy skills can make it easier for students to solve problems related to plant physiology material.

The facts show that the numeracy literacy level of Indonesian students is still low (Muzaki & Masjudin, 2019). If viewed from the PISA rankings, where numeracy literacy is one of the aspects assessed, Indonesian students have not shown optimal results, ranking 72nd out of 79 countries (Utaminingsih & Subanji, 2021). Starting from elementary school, mathematical literacy is low (Latifah et al., 2023; Ningrum et al., 2014; Puji et al., 2023; Rakhmawati & Mustadi, 2022; Siregar, 2022). Likewise, the numeracy literacy skills of high school students are still low (Andriani et al., 2022; Yosmar et al., 2019), and students' quantitative literacy skills are not yet satisfactory (Nuraeni et al., 2015; Srimuliati, 2018). This shows that the numeracy achievements of Indonesian students have not shown encouraging results.

The Indonesian government has launched the National Literacy Movement program and the National Assessment as a replacement for the National Examination. The National Assessment contains a Minimum Competency Assessment (AKM), which tests basic competencies, one of which is numeracy. It is hoped that the results of the AKM numeracy will be able to become a reference for implementing improvements and improving the system and quality of education in developing numeracy skills (Meriana & Murniarti, 2021).

Of the many studies on numerical literacy in general and several studies on numerical literacy summarized by Deda et al. (2023) shows that the most researched level of education is junior high school and early childhood education, with the main field being mathematics. Research on numerical literacy among university students is still very limited, especially in the field of science/biology, especially those related to plant physiology.

In general, this research aims to reveal the numerical literacy profile of Biology students related to plant physiology material, especially regarding practical material on the accumulation of mineral nutrients in plant cells, nutrient culture, water potential and osmotic potential, and the level of conceptual change. The expected benefit from the results of this research is that it can develop the quality of learning and improve learning outcomes at a higher numerical level.

METHODS

Research Design

The method used in this research is pre-experimental, with a pre-experimental design type one-group pre-test post-test design according to (Creswell, 2010). One group of students was given a pre-test (a test carried out before learning), which is continued with practicum implementation and responses and ends with the post-test (Table 1).

Table 1.
Pre-experimental, One Group Pre-test Post-test Design

Experimental Group	**Pre-test**	**Treatment**	**Post-test**
	O_1	X_1	O_2

Note
O_1 : Preliminary data (pre-test) on numerical literacy
O_2 : Final data (post-test) on numerical literacy
X_1 : Plant Physiology Practicum and its response

Population and Samples

The population in this study was students at the Department of Biology Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia Bandung, Indonesia. The sample in this study was 66 students from the Department of Biology Education, class of 2021, consisting of 32 Biology Education Study Program students and 34 Biology Study Program students who are currently contracting Plant Physiology courses in the odd semester of 2022/2023. Of all the participants, 10 were men, and 56 were women, and the majority came from West Java.

Instrument

The research instrument includes a set of numerical literacy pre-test and post-test questions in the form of multiple choices regarding practical material on the accumulation of mineral nutrients in plant cells, nutrient culture, water potential and osmotic potential, a set of essay questions to respond to Plant Physiology practical material with the same aspects as the pre-test and post-test questions, but the discourse is different. These numerical literacy questions refer to the aspects raised in the Minimum Competency Assessment/AKM (*Pusat Asesmen dan Pembelajaran*, 2020) namely containing the cognitive level of applying and reasoning, the context is scientific, and the mathematical content is algebra (Table 2). All the numerical literacy questions used have been analysed using the ANATES program, and the results show that the reliability of the questions reaches a value of 0.65, which is considered high, and the average validity value of the questions is 0.48, which is in the sufficient category.

Table 2.
Mapping Plant Physiology practicum questions into AKM numerical literacy aspects.

Numerical Literacy Indicators	**No. Pretest Posttest Questions**	**No. Question Response**	**Cognitive Level**	**Context**	**Mathematical Content**
Applying operations to calculate the volume of $AgNO_3$ solution used to titrate plant extracts	1	-	Applying	Scientific	Algebra
Applying operations to calculate the volume of $AgNO_3$ solution used to titrate plant habitat solutions	2	1	Applying	Scientific	Algebra
Evaluating the procedure for calculate the ratio between Cl^- in plant extracts and Cl^- in their habitat	3	-	Reasoning	Scientific	Algebra
Applying operations to calculate chemical concentrations of complete Sach's solutions for nutrient cultures	4	2	Applying	Scientific	Algebra
Applying operations to calculate the concentration of chemical substances in	5	-	Applying	Scientific	Algebra

Numerical Literacy Indicators	No. Pretest Posttest Questions	No. Question Response	Cognitive Level	Context	Mathematical Content
Sach's solution without N elements for nutrient culture					
Evaluating the calculation procedure for dilution of Sach's solution without Fe elements for nutrient culture	6	-	Reasoning	Scientific	Algebra
Summarizing data on the results of water potential experiments for several types of tubers soaked in a series of sucrose solutions	7	3	Reasoning	Scientific	Algebra
Applying operations to calculate the sucrose solution dilution for the Chardacov experiment	8	4	Applying	Scientific	Algebra
Evaluating data from the Chardacov experiment to determine a more representative specimen	9	5	Reasoning	Scientific	Algebra
Applying operations to calculate dilution of sucrose solutions for osmotic potential experiments	10,11, 12, 13,14,15	6	Applying	Scientific	Algebra
Amount	15	6			

Procedure

This research consists of 3 stages, namely the preparation stage, the implementation stage, and the reporting stage (Figure 1). The preparation stage includes: (1) A literature study on Plant Physiology practicum materials which include the accumulation of mineral nutrients in plant cells, nutrient culture, water potential and osmotic potential. (2) A literature study on the characteristics and aspects of numeracy literacy in the AKM version. (3) Preparation of numeracy literacy questions about the accumulation of mineral nutrients in plant cells, nutrient culture, water potential, and osmotic potential for pre-test, post-test, and practicum response (Table 2). (4) The provision of Google form links to facilitate the implementation of pre-test, post-test, and responses.

The implementation stage of this research includes: (1) Pre-test of the accumulation of mineral nutrients in plant cells, nutrient culture, water potential, and osmotic potential using numerical literacy questions. (2) The implementation of the Plant Physiology practicum, which includes the accumulation of mineral nutrients in plant cells, nutrient culture, water potential, and osmotic potential. (3) After each practicum is completed, all students are assigned to answer a set of response essay questions. (4) Post-test of the accumulation of mineral nutrients in plant cells, nutrient culture, water potential, and osmotic potential using numerical literacy questions.

The reporting stage includes: (1) Data processing and analysis in the form of pre-test results, post-test, and practicum response results. (2) Discussion and conclusion of research results. (3) Reporting of research results.

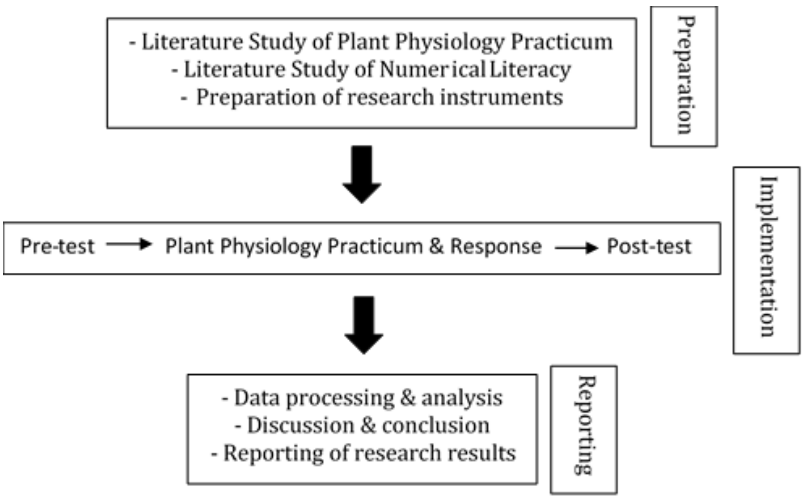


Figure 1. The research procedure

Data Analysis Techniques

The raw scores from the pre-test, post-test, and responses to the practicum results are converted to a scale of 100, and the average is calculated for each numerical literacy indicator. Based on the average value, it is then categorized into the predicate of very low to very good following the rules of Purwanto (2008).

All quantitative data, including pre-test and post-test results in classes A and C, measured the increase in mastery of numerical literacy, namely Normalized-gain (N-gain) and the category level using Hake's formula (Hake, 1998).

This research also revealed the classification of the level of conceptual change in students' numerical literacy from pre-test to post-test by adopting Lappi (2013) with some modifications. According to Lappi (2013), conceptual level change consists of 4 levels, namely Construction (Co), Revision (R), Complementation (Cp), Static (S), and Disorientation (D). The interpretation of the Construction (Co) level is that university students can do knowledge construction, while the Revision (R) level is that university students can revise their understanding. If university students can integrate new knowledge with initial knowledge into comprehensive knowledge, then it is included in the Complementation level (Cp). If university students can't change existing understanding into better understanding, then it is said to enter Static level (S). If university students experience changes in understanding that are worse than the initial understanding, it is called Disorientation (D).

According to Lappi (2013), conceptual level change is applied as follows. If the student's category in the pre-test is very low, and in the post-test, it is in the category of low to very good, then the level of conceptual change is Construction (Co). If the student's category in the pre-test is low, and in the post-test, it is in the moderate to very good category, then the level of conceptual change includes Revision (R). If the student category in the pre-test is considered moderate, and in the post-test, it is included in the good to very good category, as well as students whose pre-test is good and post-test is very good, then the level of conceptual change includes Complementation (Cp). If the student's category in the pre-test and post-test remains the same, then the level of conceptual change is Static (S), and if the category decreases from pre-test to post-test, it is called Disorientation (D).

RESULTS AND DISCUSSION

Table 3 shows that the average numerical literacy of Biology students before the Plant Physiology practicum was classified as very low, namely 42.7, and after the practicum, the response was carried out, it was moderate with an average score of 62.1. Biology students' numeracy literacy which is in the moderate category is almost the same as high school students' numeracy literacy in environmental change material which is dominated by questions in the interpretation domain (Febrianti et al., 2021), whereas in this study the questions were at the applying & reasoning level (Table 2). Likewise, students' numerical literacy skills are in the medium category in the human coordination system material (Harianto et al., 2017). This is somewhat different from Spanish undergraduate students of Biology enrolled in a Plant Physiology course whose numeracy literacy is still low (Vila & Sanz, 2013).

Table 3.
Numerical literacy ability of biology students for each indicator, category, and level of conceptual change

No.	Numerical Literacy Indicators	Student Mastery Value (%) & Categories			Level of Change Categories
		Pretest	Response	Posttest	
1.	Applying operations to calculate the volume of $AgNO_3$ solution used to titrate plant extracts	58.8 Low	-	51.5 Very low	Disorientation
2.	Applying operations to calculate the volume of $AgNO_3$ solution used to titrate plant habitat solutions	50.0 Very low	80.2 Good	64.7 Moderate	Construction
3.	Evaluating the procedure for calculate the ratio between Cl^- in plant extracts and Cl^- in their habitat	5.9 Very low	-	8.8 Very low	Static

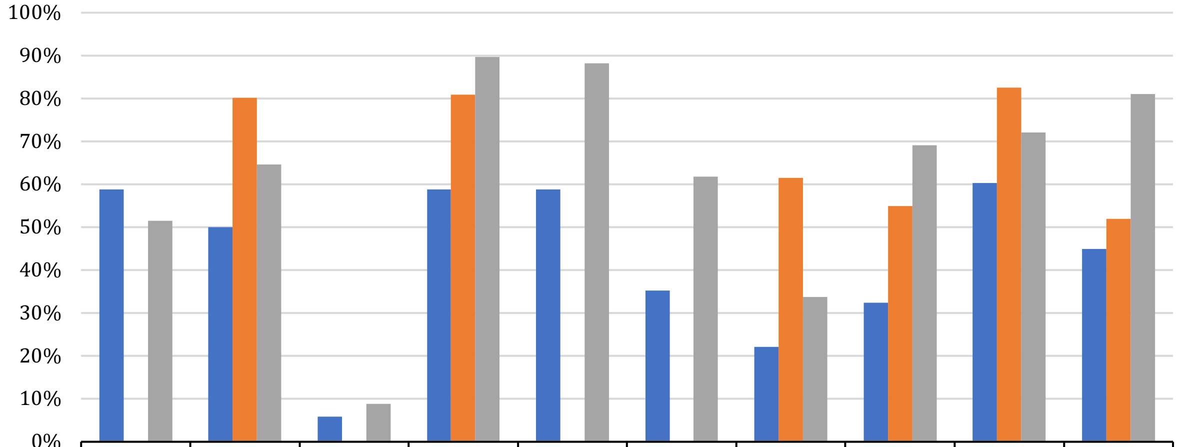
4.	Applying operations to calculate chemical concentrations of complete Sach's solutions for nutrient cultures	58.8 Low	80.9 Good	89.7 Very good	Revision
5.	Applying operations to calculate the concentration of chemical substances in Sach's solution without N elements for nutrient culture	58.8 Low	-	88.2 Very good	Revision
6.	Evaluating the calculation procedure for dilution of Sach's solution without Fe elements for nutrient culture	35.3 Very low	-	61.8 Moderate	Construction
7.	Summarizing data on the results of water potential experiments for several types of tubers soaked in a series of sucrose solutions	22.1 Very low	61.5 Moderate	33.8 Very low	Static
8.	Applying operations to calculate the sucrose solution dilution for the Chardacov experiment	32.4 Very low	55.0 Low	69.1 Moderate	Construction
9.	Evaluating data from the Chardacov experiment to determine a more representative specimen	60.3 Moderate	82.5 Good	72.1 Moderate	Static
10	Applying operations to calculate dilution of sucrose solutions for osmotic potential experiments	44.9 Very low	51.9 Very low	81.1 Good	Construction
	Overall Average	**42.7 Very low**		**62.1 Moderate**	**Construction**

The average level of conceptual change in Biology students through numerical literacy in this study is in the construction category; that is; students can construct their knowledge, marked by a change from the category of very low to moderate. Table 4 also shows that the average increase in numerical literacy is relatively low, namely with an N-gain value of 0.34.

Table 4.
Increasing student numerical literacy and the categories for each indicator

No	Indicators	N-Gain	Categories
1.	Applying operations to calculate the volume of AgNO3 solution used to titrate plant extracts	-0.18	Low
2.	Applying operations to calculate the volume of AgNO3 solution used to titrate plant habitat solutions	0.29	Low
3.	Evaluating the procedure for calculate the ratio between Cl- in plant extracts and Cl- in their habitat	0.03	Low
4.	Applying operations to calculate chemical concentrations of complete Sach's solutions for nutrient cultures	0.75	High
5.	Applying operations to calculate the concentration of chemical substances in Sach's solution without N elements for nutrient culture	0.71	High
6.	Evaluating the calculation procedure for dilution of Sach's solution without Fe elements for nutrient culture	0.41	Medium
7.	Summarizing data on the results of water potential experiments for several types of tubers soaked in a series of sucrose solutions	0.15	Low
8.	Applying operations to calculate the sucrose solution dilution for the Chardacov experiment	0.54	Medium
9.	Evaluating data from the Chardacov experiment to determine a more representative specimen	0.30	Low
10	Applying operations to calculate dilution of sucrose solutions for osmotic potential experiments	0.66	Medium
	Overall Average	**0.34**	**Low**

The lowest numerical literacy indicator before the Plant Physiology practicum was indicator number 3 which evaluated the procedure for calculating the ratio between Cl^- in plant extracts and Cl^- in their habitat (Table 3; Figure 2). In the question containing the numerical literacy indicator no.3, students are asked to reason about the procedure for calculating the ratio between Cl- in the plant extract *Rotala sp*. with Cl^- in the aquarium, each plant extract and habitat should be diluted first, not titrated directly using 0.02 N $AgNO_3$ solution (Diana et al., 2023; Mairizki et al., 2023). In other literature, it is stated that the determination of Cl^- can be done through titration using 0.5 M HNO^3 (Islam et al., 1983). Only a small percentage of students can answer this question correctly, as well as in the post-test, so the conceptual change is categorized as static. This is likely to happen when students answer essay questions at a cognitive level while still applying namely using the formula V1N1=V2N2, whereas in the pre-test and post-test questions, the cognitive level was already reasoning/evaluating. Please note that there are pre-test questions, post-test questions, and response questions. The material is the same, but the numbers are different; this is so that students do not memorize the answer key.



	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6	Indicator 7	Indicator 8	Indicator 9	Indicator 10
Pretest	59%	50%	6%	59%	59%	35%	22%	32%	60%	45%
Response		80%		81%			62%	55%	83%	52%
Posttest	52%	65%	9%	90%	88%	62%	34%	69%	72%	81%

Figure 2. Biology students' mastery of numerical literacy in the Plant Physiology practicum

The other lowest numeracy literacy indicator before the Plant Physiology practicum is indicator no. 7, namely summarizing data on the results of water potential experiments for several types of tubers soaked in a series of sucrose solutions (Table 3; Figure 2). In the question containing the numerical literacy indicator no. 7, Students are asked to analyze and conclude data from water potential experiments on several types of tubers that show isotonicity with sucrose solution. Only about 22% of students concluded correctly on the pretest, namely a sucrose solution which does not affect changing tuber length. A sucrose solution that does not have turgid and plasmolysis effects indicates an isotonic solution (Taiz et al., 2018). In the post-test, only a small number of students were able to answer it with a very low rating, so it is categorized as static conceptual change. It turns out that in the response, students answered this question only in the sufficient category (61.5) (Table 3; Figure 2).

In the posttest, the highest achievements were in indicators no. 4, 5, and 10 (Table 3; Figure 1). Numerical literacy indicator no. 4 is applying the complete Sach's solution chemical concentration operation for nutrient culture, which the student mastered with a score of 89.7, which is considered very good. Initially, students only achieved a score of 58.8 (less) on the pretest, becoming very good on the posttest, so that the level of change in mastery is in the revision category. This means that students can revise their knowledge about nutrient culture practicum. The level of conceptual change in the revision category also occurred in the numeracy literacy indicator no. 5, namely applying the operation to calculate the concentration of chemical substances in Sach's solution without the element N for nutrient culture. Especially for indicators no. 4 and 5, the N-gain is high, namely 0.75 and 0.71 respectively (Table 4).

Applying calculation operations for dilution of sucrose solutions for osmotic potential experiments is an indicator of numeracy literacy number 10, which provides a construction effect on Biology students after carrying out practical work on osmotic potential and its response. Indicator number 10 consists of 5 numerical literacy questions (Table 2). In questions no. 10-15, students are asked to calculate the volume of concentrated sucrose solution that must be diluted to make a more dilute sucrose solution. In the post-test, about 80% of students were able to answer that to dilute the solution using the formula V1N1=V2N2. This is in accordance with the formula V1N1=V2N2 for the dilution of stock solutions (Indrawati et al., 2023; Setiaji et al., 2012).

From Figure 3, initially almost 80% of Biology students had very low numeracy literacy, and about 20% of students fall into the moderate category. It's different in the post-test students in the very low category only remained about 30%, and those in the moderate category increased to almost 50%. In the good category, it has increased to close to 20%, and students have emerged who are in the very good category in the post-test. This shows that the Plant Physiology practicum, with its responsiveness, provides quite a good contribution so that it has the potential to increase the numeracy literacy of Biology students. This is reinforced by the results of the questionnaire, which stated that the majority of students responded very positively to the practicum and its response, which promoted numeracy literacy.

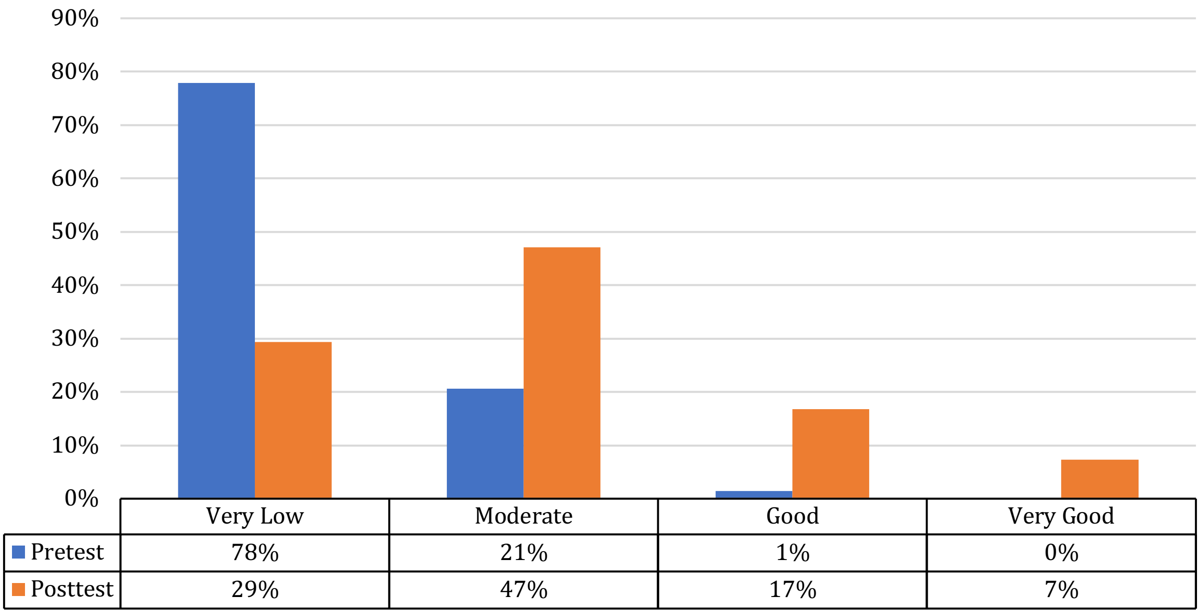


Figure 3. Category Biology students' mastery of numerical literacy in the pre-test and post-test.

From Figure 4, it can be seen that in general, about 60% of students have been able to construct their knowledge from the category of very low to moderate, good category, and very good category. In Table 3, it can be seen that the level of conceptual change in construction was obtained by calculating the volume of $AgNO^3$ solution used for titration of the plant habitat solution, calculating the dilution of a sucrose solution for Chardacov's experiment, and calculating the dilution of sucrose solutions for osmotic potential experiments. It seems that Biology students in constructing the concept of dilution and calculating the volume of solution for titration by increasing their numeracy level, are still limited to applying formulas, although the construction level also occurs in the indicator evaluating the calculation procedure for dilution of Sach's solution without Fe elements for nutrient culture.

In this research, a static conceptual level was still found (Figure 4) in the very poor category, namely indicator no. 3 (evaluating the procedure for calculating the ratio between Cl^- in plant extracts and Cl^- in their habitat) and indicator no. 7 (summarizing data on the results of water potential experiments for several types of tubers soaked in a series of sucrose solutions) (Table 3). The level of static conceptual change in the moderate category occurs at indicator number 9, namely evaluating data from the Chardacov experiment to determine a more representative specimen. This shows that the level of cognitive reasoning is relatively difficult to increase in numerical literacy, and certain treatment must be carried out; for example, students are more often given tasks that require reasoning. This low increase in high-level thinking abilities also occurs in Biology students in mastering plant metabolism, especially at the analysis cognitive level using cooperative learning jigsaw (Diana, 2019).

The revision level of conceptual change occurs in less than 10% of students (Figure 4) namely an increase from the low to very good category. The level of conceptual change in this revision is found in the indicator for calculating the chemical concentration of a complete Sach's solution and Sach's solution without N elements for nutrient culture. This shows that less than 10% of students succeeded in revising the concept of calculating the chemical concentration of Sach's solution to be very good.

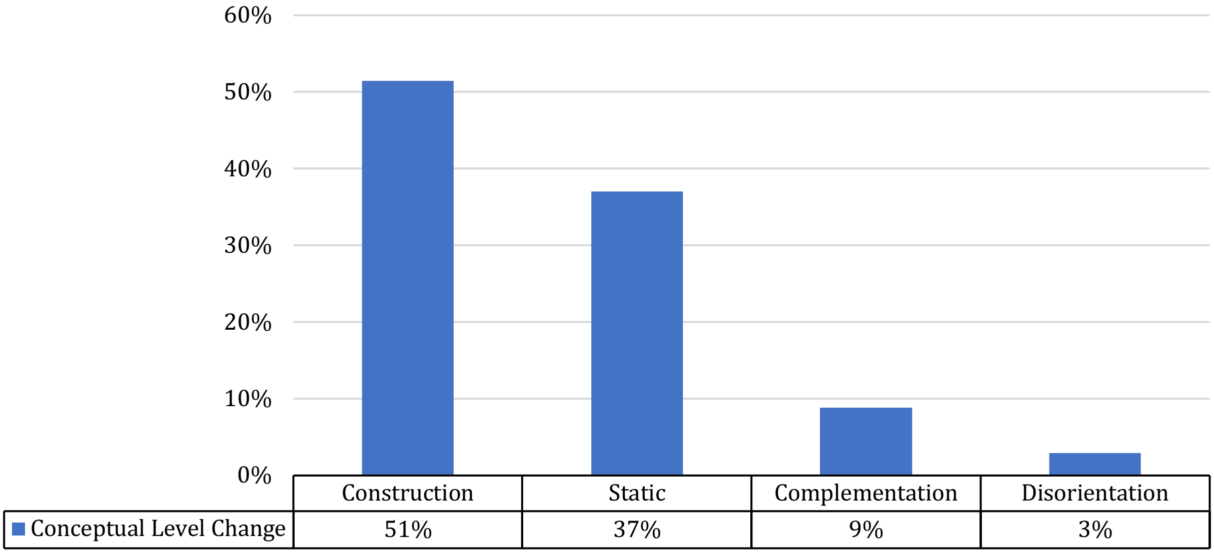


Figure 4. Conceptual change level of Biology students as a whole.

There was only one person or around 2% of students who experienced disorientation (Figure 4) from the low category to the very low category on the indicator for calculating the volume of $AgNO^3$ solution used to plant extracts titration and the N-gain is low (-0.18) (Table 4). One of the factors causing low quantitative literacy is the weak provision of quantitative literacy in learning (Siregar, 2022; Srimuliati, 2018; Utami, 2022). In this research, this could happen due to several possibilities. First, there is a lack of provision by the lecturer during the introduction to facing the practicum and when discussing the results of the practicum as well as discussion about response (Srimuliati, 2018). Lack of reinforcement by lecturers can also trigger changes in the level of mastery of the static concepts above. Second, the questions used for the pretest, posttest, and responses to measure students' numeracy literacy were limited in quantity and scope (Table 2). The pretest and posttest questions are in the form of multiple-choice choices, while the responses use essay questions. Apart from that, the number of questions for response and pretest posttest should be increased in quantity and cognitive level from applying to more reasoning. Also, measuring conceptual change should be in the form of an essay and not using multiple choice questions that allow students to guess the answer. This was also conveyed by Srimuliati (2018), who said that innovating learning assessment instruments is one effective way to increase students' quantitative literacy. It is necessary to provide training and socialization on numerical literacy, getting used to implementing numerical literacy, providing programs and infrastructure for learning numerical literacy, maximize the use of learning media and increase hours of learning activities (Latifah et al., 2023; Siregar, 2022; Utami, 2022). Aziz & Safitri (2023) also stated that many teachers still do not care about the role of mathematics in daily life. According to Wahyuni (2022), there are obstacles faced by teachers in implementing numeracy literacy in schools, including the teacher's lack of understanding regarding numeracy literacy. Apart from that, mastery of the subject matter used in solving numeracy literacy questions also plays a role in determining students' numeracy literacy (Andriani et al., 2022). According to Deda et al. (2023), improve numerical literacy must start from an early age and must involve the role of parents, because several studies state that students who are less strong in numeracy literacy can be influenced by less educated families.

Another weakness of this research is the possibility that practical students are less involved in practicum preparation, especially in providing the quantity and type of materials to be used. It is a good idea for practical students to be directly involved in providing practical materials including the calculations, which so far have been provided by practical assistants and laboratory assistants. In this way, practical students will not only hone their numeracy literacy but can directly develop their laboratory skills. Another recommendation is to develop numeracy literacy in other Plant Physiology practicums as has been done by Zumira et al. (2022) by developing an alternative Ingenhousz photosynthesis practicum containing quantitative literacy. Learning Plant Physiology can also be combined with the use of gamification (PHYSIOGAM), namely a simulator plus gaming which can generate data to be used as a vehicle for practicing calculating plant responses between two plants of the same or different species and modifying atmospheric CO_2 concentration, photosynthetic active radiation (PAR), air temperature, air relative humidity and soil water potential for each plant (Venturas et al., 2024).

CONCLUSION

Through the practical implementation of mineral nutrient accumulation in plant cells, nutrient culture, water potential, and osmotic potential with their responses, there was an increase in student numerical literacy from the very low category to the moderate category, with the level of conceptual change in the construction category and the N-gain is low. Thus, the implementation of Plant Physiology practicums and their responses have the potential to increase student numerical literacy. It's just that the implementation needs to be improved, for example, involving more practical students in preparing practical materials and strengthening lecturers in their response, increase the quantity and quality (cognitive level) of pretest posttest questions and response questions.

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