



THE USE OF VLAB PLANTAE TO PROMOTE JUNIOR HIGH SCHOOL SCIENCE STUDENTS' CONCEPTUAL UNDERSTANDINGS OF PLANT GROWTH AND DEVELOPMENT

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Abstract

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We used a qualitative approach with an explanatory case study method to examine students' conceptual understandings of plant growth and development before and after using the VLab Plantae application. Task-based interviews were applied to 12 ninth-grade students from class IX. Before and After interview, their conceptual understandings of four domains were examined, i.e., imbibition, germination, growth factors, and the growth process. The students were tasked to work with VLab Plantae based on interview protocols. The findings show that VLab Plantae improves students' conceptual understandings, with the most significant gains in imbibition. Students grasped germination and growth processes through visual experiments with red beans and corn seeds. While all concepts in the four domain were identified during the use of VLab Plantae, our study suggests that teachers remain crucial in guiding students to use the VLab Plantae to comprehend the related concepts.

INTRODUCTION

Science can be defined as the study of all phenomena that occur in nature, both related to living and non-living things (Hakim et al., 2022: 2). Activities in science learning often involve concepts that are difficult to understand, so students have difficulty drawing conclusions from the material presented (Ningrum and Utomo, 2024). Science concepts on plant growth and development material include one of the important topics in science learning (Mulyani et al., 2023). Understanding of science concepts can be defined as the ability that students must have to understand science learning material, both in theory and its application in everyday life (Safitri et al., 2023). Students' understanding of concepts in the learning process is still relatively low, it can be seen how students are still able to understand, understand, and re-express in their own sentences without changing the meaning (Meha et al., 2022). Research by Fatimatuzzohrah et al., (2020) revealed that the factor of low understanding of science concepts is caused by a combination of the way students receive, organize, and process information. The low understanding of concepts according to Sihotang et al., (2024) states that, it appears that most teachers still tend to use conventional teaching methods. The results of Riyanti et al.'s research (2024) show that, increasing concept understanding occurs through the application of technology that provides effective learning experiences and encourages student activeness in learning. Concept understanding is said to increase if the final concept understanding value is higher than the initial concept understanding.

Information technology-based learning media uses electronic systems to process data digitally which continues to experience rapid development in the form of a combination of text, images, animation, audio, and video in electronic media is expected to allow users to interact, explore content, create, and communicate (Latifah et al., 2022). Information delivery with technology can be done through virtual laboratory applications for experimental topics (Afriyanty et al., 2024). The use of virtual laboratories makes it easier for students to understand science concepts that are difficult to understand through visualization

(Mawarti et al., 2023). Virtual laboratory is considered very effective for improving concept understanding (Firdaus, 2023).

The VLab Plantae application is a learning media that is carried out through simulations on experimental activities that are generally carried out in the laboratory to understand a concept or object that is difficult to understand (Qurniati, 2022). The use of virtual laboratories with the VLab Plantae application is still commonly used and has not been widely researched as evidenced by limited previous research, so researchers take virtual laboratory research materials that utilize websites or other applications in science learning activities. Sanimah et al., (2024) stated that, virtual laboratory platforms that are widely used, for example, Chemcollective, Olabs and PhET, can improve concept understanding and student participation in science learning. Researchers introduced the VLab Plantae application to determine students' concept understanding before and after going through the learning process of plant growth and development material. Increased understanding of concepts based on Wati's research (2021) states that, the use of virtual lab applications can improve student learning outcomes as evidenced by better understanding the concept of material through the use of virtual labs, and students are more assisted by the application. Based on the problems that have been described, to prove whether the VLab plantae application affects the understanding of science concepts. Researchers are interested in conducting research with the title "The Use of VLab Plantae Application to Promote Junior High School Science Students' Conceptual Understandings of Plant Growth and Development".

Based on the background that has been described, to prove whether the VLab plantae application affects the understanding of science concepts. (i) How is the understanding of student concepts before and after using the VLab Plantae application? (ii) How is the process of students learning plant growth and development material using the VLab Plantae application?.

METHOD

A. Research Design

Our research employed a qualitative approach with a case study research method to explore and gain an understanding of how the use of the VLab Plantae application on students' concept understanding of plant growth and development material. Case study research with an exploratory case study design type was conducted one by one to assess the contribution of the VLab Plantae application to each student's concept understanding in the material.

B. *Research Participants*

The research involved 12 students taken from class IX. The subjects selected in this study with the provisions, namely the subject has never known or used the VLab Plantae application, the subject has not obtained plant growth and development material in junior high school, and the subject has been given information related to research and participated voluntarily given through a consent letter.

C. *Instrument and Procedures*

Research data collection techniques based on initial assessment, final assessment, and structured interviews on an one by one basis between students and researchers and recorded using a camera or voice recorder During the learning process with an estimated time of 60 minutes through the procedure shown in Figure 1.

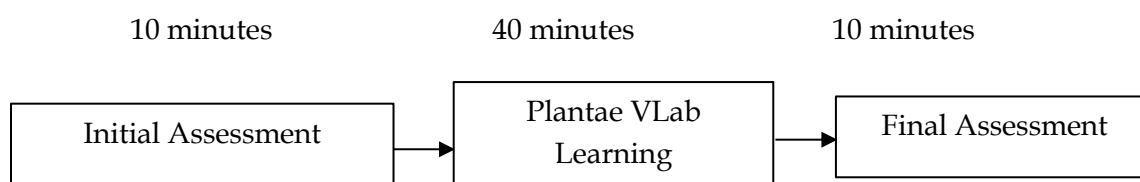


Figure 1. Research Procedures

D. *Data Analysis*

Based on the instruments and data collection techniques, a data analysis method is needed to obtain the following research results:

1. *Grouping of Initial Assessment and Final Assessment*

Data used to answer the first problem formulation consists of initial assessment data and final assessment. This analysis aims to assess students' understanding of

concepts by comparing changes in scores before and after using the VLab Plantae application and grouped based on the results of the initial assessment and final assessment according to the understanding of the concept of plant growth and development material.

2. Interview Processing

The data used to answer the second problem formulation is structured interview data. This analysis aims to analyze students' concept understanding during the learning process using the VLab Plantae application. Assessment was carried out on interview data at each step of the experiment. Student response criteria were used to summarize the results of individual interview analysis by comparing and contrasting students' concept understanding.

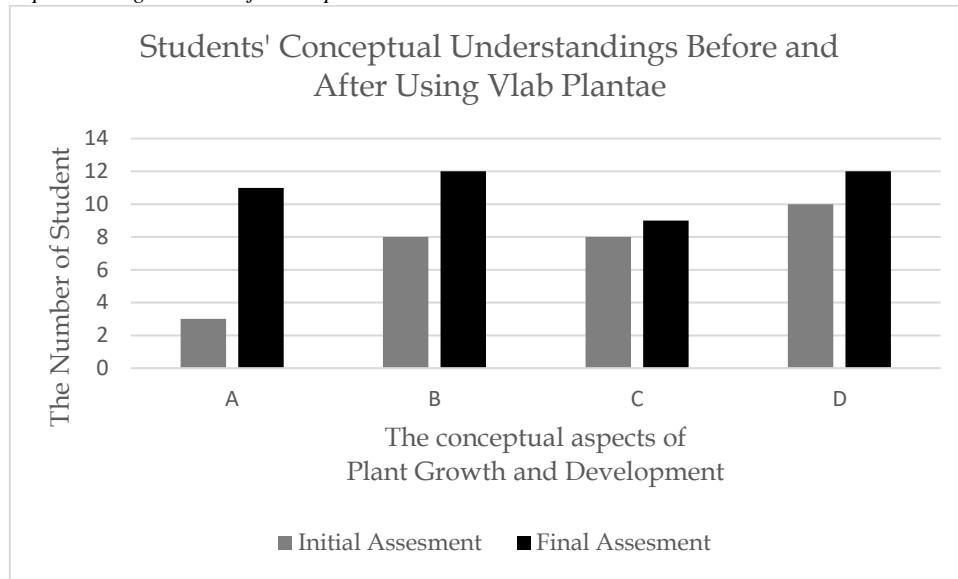
RESULTS AND DISCUSSION

A. Results

This chapter presents the results and its discussion related to the research questions, namely, the understanding of student concepts before and after using the VLab Plantae application, as well as the process of students learning plant growth and development material using the VLab Plantae application. The concept of plant growth and development is analyzed through data collection in the form of, interview transcriptions, initial assessment test data final assessment, and documentation that has been done in class IX MTs Negeri 2 Jember.

1. Research question (i): Student Conceptual Understandings Before and After Using the VLab Plantae Application

Figure 2 is a bar chart of students' concept understanding before and after using the VLab Plantae application. The description of Figure 1 is that the x-axis shows students' answers in the initial and final tests. The y-axis represents the number of students who can answer correctly related to the four aspects of understanding the concept of plant growth and development.



Description:

Aspect A: Imbibition

Aspect B: Germination

Aspect C: Growth and development factors

Aspect D: Growth and development process

Figure 2. The aspects of the Concepts of Plant Growth and Development

Figure 2 shows that there is an increase in the concept of each Aspect, which means that more students answer correctly after using the VLab Plantae application. The biggest concept improvement is shown in Aspect A (imbibition), characterized by changes in the number of students who answer the most concepts correctly compared to other concepts after using the VLab Plantae application. The following is an explanation of the analysis results for each Aspect.

1. Aspect A

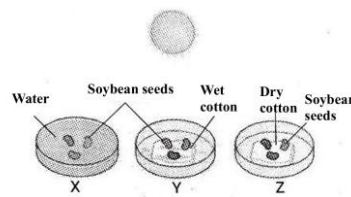


Figure 3. Aspect A, question number 4

In aspect A, students were asked to summarize the results of treating soybean seeds under various conditions involving water, wet cotton, and dry cotton. Students who could not answer correctly were considered not to have mastered the concept of imbibition. Aspect A is represented by S10, which shows the changes in each of the X, Y, and Z treatments. The following are examples of concept changes in Aspect A for treatments X, Y, and Z.

Table 1. Analysis of student S10's Aspect A

Aspect A	Treatment	Initial answer	Student Answer Excerpt
Students are able to analyze the imbibition process in seeds during germination.	x		"P: What does this picture of X have in it? S10: There is water and soybean seeds. P: If there is only water and soybean seeds, how will it grow? S10: "It will be slow to grow and it won't even grow, the seeds will rot because it's too much water".
	y	Soybean seeds will grow	"P: What will be the growth of this Y-image? S10: It will gradually grow every day because the tools and materials are complete".
	z		"P: How will it develop in figure Z? S10: It won't develop. P: Why won't it grow? S10: Because the cotton under the seeds is dry, so the seeds can't grow because there is no moisture"

The results of the S10 analysis are considered to have mastered treatments X, Y, Z because they are able to analyze each condition contained in each cup. Treatment X, students are able to analyze the condition of seeds in a cup containing only water and soybean seeds stating that, the growth of seeds will be slow or even the seeds will decay. Treatment Y, students are able to analyze the condition of seeds in a cup containing water, soybean seeds, and wet cotton stating that, the seeds will grow well every day, because they have fulfilled the concepts needed for seed growth. Treatment Z, students are able to analyze the condition of seeds when placed in a cup with dry cotton stating that, seeds will remain dry and will not grow due to the absence of moisture factors. Before using the VLab Plantae application, student S10 had not mastered the X, Y, Z treatments with less specific answers related to the treatment between X, Y, or Z, such as "Soybean seeds will grow". This indicates that student S10 has understand each treatment.

2. Aspect B

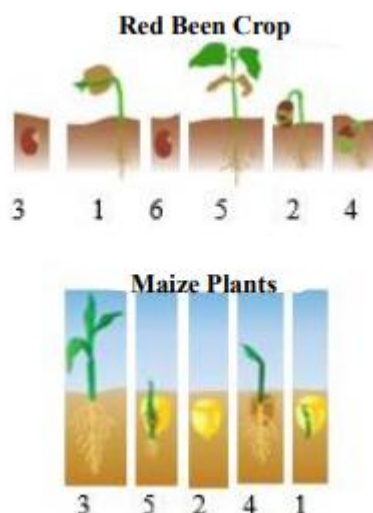


Figure 4. Aspect B, question number 2

Aspect B, students were asked to sequence the steps of growth and development of kidney bean and corn plants. Students who are unable to understand the sequence correctly are considered not to have mastered the concept of germination. Aspect B is represented by S12, because it shows a change in sequencing the steps of growth. The following is an example of concept change in Aspect B on red bean and corn plants.

Table 2. Analysis of student S12's Aspect B

Aspect B	Question	Student Answer Excerpt
Students are able to understand the differences in various kinds of germination based on the location of the cotyledons.	Red Beans	<p>3,6,4,2,1,5</p> <p>"P: Now you have learned from the growth of kidney beans and corn kernels, so if the kidney beans started at which step of growth? S12: 6 [points to number 6], 3 [points to number 3], 4 [points to number 4], 2 [points to number 2], 1 [points to number 1], 5 [points to number 5]".</p>
	Corn	<p>4,2,1,3,5</p> <p>"P: What about the corn plant? S12: 2 [points to number 2], 1 [points to number 1], 5 [points to number 5], 4 [points to number 4], 3 [points to number 3]".</p>

The results of the analysis of student S12 are considered to have mastered the concept of Aspect B (germination), because they are able to understand the sequence of

red bean and corn plants correctly after using the VLab Plantae application. Student S12 before using the VLab Plantae application had not mastered Aspect B, because he was unable to sequence the corn plants correctly. However, they were able to sort the red bean plants correctly. This indicates that student S12 has understand Aspect B.

3. Aspect C

Aspect C is the concept of factors that affect growth and development. Aspect C ability is found in questions number 1a and 1b. Aspect C is represented by S1, because it shows a change in determining growth and development factors. The following is an example of Aspect C question number 1a.

"Name 3 external factors that affect plant growth and development!"

Aspect C of question number 1, students are asked to mention a maximum of 3 external factors that affect plant growth and development. Students who give answers less than 3 are considered not mastering the concept of Aspect C (growth and development factors). The following is an example of changes to Aspect C of question number 1a.

Table 3. Analysis of student S12's Aspect B

Aspect C	Initial answer	Student Answer Excerpt
Students are able to mention the factors that affect plant growth and development	Environment, weather, and...	<i>"P: what factors affect the growth and development of the two plants, if external factors mean factors from outside the plant, what factors are there? How many are there? S1: Three P: What are there if three? S1: Light P: Light, do you know that there is a light factor at what time? S1: When it was put in the window P: Heem when it was moved in the window? S1: Yes P: Then what is the second factor? S1: Humidity P: Moisture, do you know there is a moisture factor at what step? S1: When the water and tissue were put in the same container with the seeds so the tissue was moist from the water"</i>

The results of the analysis of S1 students are considered to have mastered Aspect C (germination factors) in question number 1, because they are able to remember by mentioning a maximum of 3 external factors completely and precisely. Before using the VLab Plantae application, student S1 had not mastered Aspect C in question number 1 by

giving incomplete and less specific answers, such as “environment, weather, and ...”. This indicates that, student S1 has understand Aspect C of question number 1a.

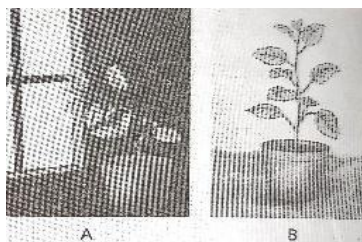


Figure 5. Aspect C of question number 1b

Aspect C ability is also found in question number 5 about factors that affect plant growth and development. The following is an example of Aspect C in question number 1b.

Aspect C of question number 1b, students are asked to evaluate environmental factors involving sunlight on plant growth and development based on treatment A and treatment B. Students who are unable to evaluate the differences between the two plants appropriately are considered not to have mastered Aspect C in question number 1b.

Table 4. Analysis of Aspect C of student S1 question number 1b

Aspect C	Question	Initial Answer	Student Answer Excerpt
Students are able to mention the factors that affect plant growth and development	A	A: there is less sunlight in the house	<p>“P: Now, if you look at picture A, the plant is placed inside the room and the shape is turning, if picture B is outside the room, the shape is straight up, why are the pictures A and B different from picture A first! S1: For example A because the sunlight comes from one direction. P: Heem one direction, from which direction? S1: From the window. P: From the window, why does it cause? S1: The deflection. P: What is the deflection? S: The plant”</p>
	B	B:...	<p>“P: In picture B, why is the plant perpendicular to the top? S1: Because of the sunlight. S1: It goes all the way to the plant what is it, the sunlight of this plant shines on everything so it hits everything”</p>

The results of the analysis of student S1 (treatment A) are considered to have mastered Aspect C in question number 1b, because they are able to evaluate the differences between the two plants by providing an explanation based on the picture presented. Student S1 stated that, plant A can tilt towards the window because sunlight from one direction comes from the window, causing it to tilt towards the window. Before using the VLab Plantae application, student S1 had understand treatment A, but the answer was still simple and less specific such as, "A: in the house less sunlight". This indicates that S1 students mastered the concept of Aspect C which was further developed after using the VLab Plantae application, seen from the answers that were more in-depth and detailed.

The results of the analysis of student S1 (treatment B) stated that, plant B can go straight up because of the influence of sunlight entering the entire plant body when placed outdoors. Before using the VLab Plantae application, student S1 had not mastered the concept of treatment B because he was not able to explain treatment B when it was outdoors, by giving answers such as "B:...". This indicates that, student S1 has understand Aspect C of question number 1b in treatment B.

4. Aspect D

Aspect D is the concept of the growth and development process to ensure seeds can grow optimally. The ability of Aspect D is found in question number 3 represented by S7, because it shows a change. The following is an example of Aspect D in question number 3.

"Anton conducted an experiment by growing red bean seeds using cotton or wet tissue. What are the steps Anton must take to ensure the seeds can grow optimally?"

Aspect D, students are asked to organize each step based on observations so that the seeds can grow optimally. Students who are unable to organize correctly are considered not understand Aspect D.

Table 5. Analysis of student S12's Aspect D

Aspect D	Initial answer	Student Answer Excerpt
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Students are able to apply each step of plant growth and development

Using Fertilizer

"P: Now, you already know the steps in preparing the experiment. When the materials are placed on the table, what do you do first? What are the steps? First, what do you do? S7: Emm, put the tissue, red beans and corn kernels, another tissue oh given water, put on the window"

The results of the analysis of student S7 are considered to have understand Aspect D, because they are able to apply the preparation of steps based on observations to ensure that the seeds can grow optimally starting from putting tissue, red bean and corn seeds, water, and placed near the window. Before using the VLab Plantae application, student S7 had not understand Aspect D with answers that did not show the experimental steps that Anton had to do, such as "using fertilizer". This shows that student S12 is able to understand Aspect D.

2. Research question (ii): How is the process of students learning plant growth and development material using the VLab Plantae application?

Figure 6 is a scatter chart showing the concept of plant growth and development (x-axis) learned by students at each step in the VLab Plantae application (y-axis). Each scatter represents students in the learning process using the VLab Plantae application.

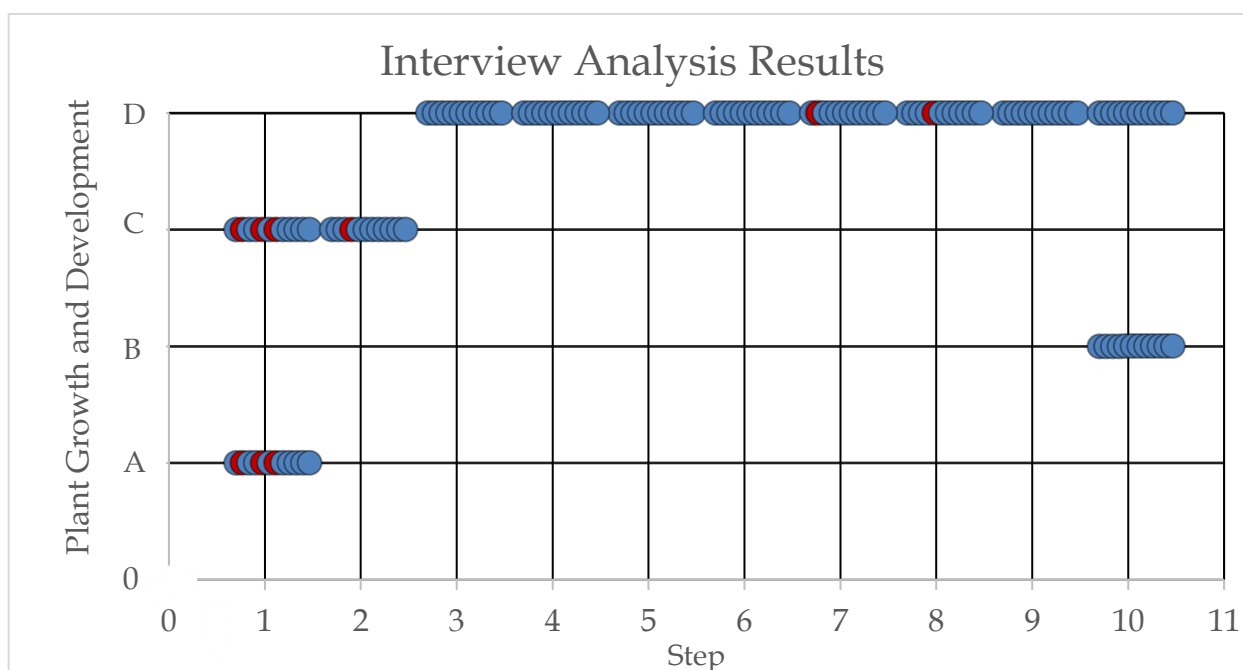



Figure 6. Growth and development concepts learned using the VLab Plantae application

Figure 6. shows the 10 steps that students learn using the VLab Plantae application. Students are able to understand two concepts at once in step 1 (Aspects A and C) and step 10 (Aspects B and D), and students learn more concepts in Aspect D (growth and development process) than other concepts. The following is an explanation of the analysis results in each Aspect.

1. Aspect A

Aspect A in step 1, students observe the concept of imbibition. During the observation process using the VLab Plantae application, the researcher asked questions to determine the extent of students' concept understanding of the imbibition process. Students who are able to answer Aspect A questions correctly are considered to have understand the concept of imbibition. Before the researcher asked questions, students were asked to put tissue, water, red bean seeds, and corn seeds into a cup, with the aim that students could understand the imbibition process through the VLab Plantae application. The following is an example of a student learning Aspect A (represented by S10).

Table 6. Analysis of interview S10 step 1 using the application on Aspect A


Frame	Aspect A	Student Answer Excerpt
	<p>Students are able to analyze the impact of imbibition on seeds during germination.</p>	<p><i>"P: Now try to read the command for what? S10: Click on the tissue to take the tissue and put it in the Petri dish. Take the red bean seeds and put them in the cup. Take the corn kernels and put them into the petri dish. Take the glass and pull it over the petri dish to pour some water into the petri dish. P: Now here you ask first, at this step if water is not given, will the seeds still experience growth and development? S10: Emm in my opinion not, because like plants in general in the soil also need water to grow P: Yes, then if you don't give water, what will happen to the seeds? S10: It won't grow, it will just become a seed P: Yes, then if tissue is not given and only water is given, will the seeds still experience growth and development? S10: No, because tissue is a growth medium like soil P: Heem Yes, what about water only? S10: If it's just water, the seeds won't grow, they'll just get wet P: What will happen to the seeds if they don't grow? S10: They will rot".</i></p>

The results of the analysis of student S10 understand Aspect A during the use of the VLab Plantae application, because they were able to observe the concept of seeds developing into plants in the imbibition process involving tissue, water, red bean seeds, and corn seeds. Student S10 stated that, in the experiment when water is not given the seeds will not experience growth and development, just like plants in general when they are in the ground, of course, they will also need water to grow. Whereas in the experiment when tissue is not given and only water is given, the seeds do not experience growth and development, but the seeds will rot. This shows that student S10 understands Aspect A.

2. Aspect B

Aspect B in step 10, students describe the concept of germination based on the location of the cotyledons. Before the researcher asks questions, students must have observed step 3 to step 9, namely, the germination process for 7 days using the VLab Plantae application. It is intended that students understand the germination of red bean and corn plants based on the location of the cotyledons. The following is an example of a student learning concept B (represented by S12).

Table 7. Analysis of interview S12 step 10 using the application of Aspect B

Frame	Aspect B	Student Answer Excerpt
	<p>Students are able to describe seed germination based on the location of the cotyledons</p>	<p><i>“P: Now I want to ask you first from day one to day seven what differences are very visible from the red bean plants and corn seeds? S12: In terms of the seeds, for example, one seed is detached [kidney bean seeds] the other is still [corn seeds] P: Still, what about the red bean seeds? S12: Detached from the plant P: Heem, before they were detached from the plant what were the seeds like? S12: Split P: Yes, split, what about the corn? S12: The corn one stays because the plant grows from the top up”.</i></p>

The results of student S12's analysis understand Aspect B during the use of the VLab Plantae application, because they were able to describe the concept of germination based on the location of the cotyledons. The results of the analysis of student S12 stated that, in the growth and development of kidney beans in terms of seeds, “the seeds are separated from the plant” and “split” which can be related to the concept of epigeal, where the cotyledons are lifted above the soil surface and will be separated from the plant,


but the answer is less specific regarding the position of the kidney bean seeds and how the process of lifting the seeds. Meanwhile, the growth and development of corn plants in terms of seeds is “still” and “fixed” which can be linked to the concept of hypogeal, where the cotyledons remain below the surface. This indicates that student S12 understands concept B, but the explanation is less specific.

3. Aspect C

Aspect C in steps 1 and 2, students determine the factors of growth and development. During the observation process using the VLab Plantae application, the researcher asked questions to determine the extent of students' conceptual understanding of the concept of growth and development. Students who are able to answer Aspect C questions correctly are considered to understand the concept of growth and development factors.

Aspect C step 1, students determine the growth and development factors in the imbibition process. Before the researcher asked the step 1 question, students were asked to put tissue, water, red bean seeds, and corn seeds into a cup, with the aim that students can understand the existence of external factors that affect the growth and development of seeds. The following is an example of students learning Aspect C step 1 (represented by S1).

Table 8. Analyze S1 interview step 1 using the application on Aspect C


Frame	Aspect C	Student Answer Excerpt
	Students are able to identify factors that affect plant growth and development	<p><i>“P: Now, what are you told to do when you read this? S1: Click on the tissue to take the tissue and put it in the petri dish. Take the red bean seeds and put them in the petri dish. Take the corn kernel and put it into the petri dish. Take the glass and pull it over the petri dish to pour some water into the petri dish. P: Yes, now you ask first, at this step if water is not given, will the seeds still experience growth and development? S1: No. P: Why not? S1: Yes, the seeds will dry out. P: Heem the seeds will be dry, now I ask again, if tissue is not given and only water is given, will the seeds still experience growth and development? S1: No. P: Why? S1: The seeds will rot”.</i></p>

The results of student S1's analysis understand Aspect C step 1 while using the VLab Plantae application, because he was able to identify factors that affect growth and development by involving tissue, water, red bean seeds and corn seeds. The results of student S1's analysis stated that, seeds will remain dry if water is not given, and seeds

will rot if only water is given without tissue. This indicates that S1 students understand Aspect C at step 1.

Aspect C step 2, students determine growth and development factors involving sunlight. Before the researcher asked step 2 questions, students were asked to move the cup to the window, with the aim that students could understand the role of the environment, such as sunlight in supporting the growth and development process of seeds. The following is an example of students learning Aspect C step 2 (represented by S1).

Table 9. Analyze S1 interview step 2 using the application on Aspect C

Frame	Aspect C	Student Answer Excerpt
	Students are able to identify factors that affect plant growth and development	<i>“P: Well, try reading this first! S1: S: Take the petri dish and place it on the window. P: Heem, try moving it first! Now you ask first, why is this Petri dish moved near the window? S1: To be exposed to sunlight. P: Heem, what if it is exposed to sunlight? S1: Yes, it can photosynthesize. P: Oh that means for photosynthesis, then you ask again what if it is not moved or remains in the room will the seeds still grow optimally? S1: No. P: Well why not? S: Later the plants can't grow optimally”</i>


The results of the analysis of S1 students understand Aspect C step 2 during the use of the VLab Plantae application, because they were able to identify factors that affect growth and development by involving sunlight. The results of the analysis of student S1 stated that, in the growth and development of plants, sunlight is needed for photosynthesis so that plants can grow optimally. This indicates that S1 students understand Aspect C in step 2.

4. Aspect D

Aspect D at step 3 to step 10, students observe each step of plant growth and development while using the VLab Plantae application. The researcher asked questions to determine the extent of students' conceptual understanding of the growth and development process. Students who are able to answer questions at each step of Aspect D correctly are considered to understand the concept of the growth and development process.

Aspect D step 3 to step 9, students observe the growth and development process of red bean and corn plants for 7 days using the VLab Plantae application. Before the researcher asked questions at each step, students were asked to observe the differences in plant changes with the previous day. The following is an example of students learning Aspect D (represented by S7).

Table 10. Analysis of interview S7 step 3 using the application on Aspect D

Frame	Aspect C	Student Answer Excerpt
	Students are able to observe each step of plant growth and development	<i>"Now try to notice the growth on the first day, is there any difference from the previous day? S7: There is P: Where is the difference, try to show it with that [cursor]! S7: This [points to the white colored part/coleoptile of corn] P: Yes, the corn one appears [coleoptile] S7: What appears on the red bean? [points to the brown colored part/rootstalk] P: That appears? S7: Yes"</i>

The results of the analysis of student S7 understand Aspect D step 3 to step 9 during the use of the VLab Plantae application, because they are able to observe each step of plant growth and development until day 7. On day 1, he stated that there was a difference by pointing to the white part of the corn (coleoptile) that grew upwards, while the kidney bean plant pointed to the brownish part (rootlets) that grew downwards. Observation of the growth and development process of corn and kidney bean plants continues at each step until day 7.

Aspect D step 10, students observe the growth process based on the location of the cotyledons. Before the researcher asks step 10 questions, students are ensured to have observed the growth and development process for 7 days using the VLab Plantae application. This aims to make students understand the differences in growth and development based on the location of cotyledons between red bean and corn plants. The following is an example of a student learning Aspect D (represented by S7).

Table 11. Analysis of interview S7 step 10 using the application on Aspect D

Frame	Aspect C	Student Answer Excerpt
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Students are able to observe each step of plant growth and development

“Q: How do the red beans grow? S7: Over time it lost its brown [the skin of the red bean seed is getting peeled off] P: Heem then, what about the corn kernels? The kernels? S7: Still, the seeds are bigger. P: Heem, if it's like this, from the first day to the seventh day, the corn is still here, but the kidney beans, from the first day to the seventh day, how did it go? S7: Followed up S7: Cut, then lost”

The results of the analysis of S7 students understand Aspect D step 10 during the use of the VLab Plantae application, because they are able to observe each step of plant growth and development until day 7, so that students are able to identify the location of cotyledons between red bean and corn plants. In the 10th step, it is stated that, in the growth and development of kidney bean seeds, “over time the brown disappears”, “comes to the top”, and “cut, then lost” which can be connected to the concept of epigeal, where the cotyledons are lifted above the soil surface along with the stems and separated from the plant. Meanwhile, the corn plant states that, “It stays” which can be related to the concept of hypogeal, where the cotyledons remain below the soil surface. This indicates that student S7 understood Aspect D after observing the growth and development for 7 days.

B. Discussion

The results of the data analysis in Figure 1 show that the use of the VLab Plantae application helps students in improving their understanding of the concept of plant growth and development material. This is in line with research Wati (2021) which states that the use of virtual lab applications can improve student learning outcomes. This increase is due to the VLab Plantae application helping students to learn the concepts of plant growth and development material. As shown in Figure 5 in step 1, students learn the concept of imbibition (Aspect A), namely by inserting the materials needed in the experiment, such as tissue, red bean seeds, corn seeds, and water into a cup, then moving it near the window. When students do this step, students learn the impact of imbibition. Wahyuni *et al.*, (2020) stated that, virtual lab is able to simulate practicum activities as if they were in a real laboratory with a form of operation through electronic media.

The findings showed that the VLab Plantae application contributed the most to the concept of imbibition (Aspect A). According to Firdaus (2023), virtual laboratory is

considered effective for improving concept understanding. This is because during the process of students learning using the VLab Plantae application, students observe the impact of imbibition, which is shown by the increasing development of red bean and corn plants until day 7. The concept of imbibition (Aspect A) is related to the concept of growth and development factors (Aspect C), namely after the seeds absorb water, there are external factors such as sunlight, while cotton is used as water storage to keep the seeds moist, so that plant growth becomes more optimal.

During the process of students learning using the VLab Plantae application, students mostly observed the concept of germination (Aspect D) by comparing the differences in growth and development of red bean and corn plants at each step until day 7. This finding is in line with the research of Tunisa & Astriani (2023), which states that the observation process equipped with visual Aspects, such as images, animations, and interesting interactive simulations, can make it easier to master science concepts. Each step in the VLab Plantae application is designed to help students master the concept of plant growth and development. This is proven to be able to help students master all concepts in the growth and development process (Aspect B) and seed germination (Aspect D). However, not all students are able to master all Aspects. Research by Fatimatuzzohrah *et al.*, (2020) stated that, the factor of low student concept understanding is caused by a combination of the way students receive, organize, and process information. Previous findings also support this finding. Mustapa *et al.*, (2022) examined various virtual laboratory platforms, such as PhET, Chemcollective, and Olabs, which are able to replace the role of real laboratories in testing scientific theories, laws, concepts, and helping students master concepts.

The solution to overcome students' problems in processing new information, the teacher gives directions to students to observe the differences in plant growth and development at each step before proceeding to the next step. Thus, students can better understand the changes that occur in red bean and corn plants that can be seen from seeds, roots, stems, and leaves from day 1 to 7. This observation process allows students to identify germination, the process of growth and development, influencing factors, and the impact of imbibition. According to Damayanti & Anando (2021), the role of the teacher is very important in learning because it helps students in the learning process and provides motivation, so that they more easily understand the material. Pahrun *et al.*, (2023) stated that, Students are considered to have mastered the concept when students

understand it well, and are able to explain again using their own sentences according to their knowledge without changing the meaning in it.

CONCLUSION

Students' concept understanding of plant growth and development material before using the VLab Plantae application is still classified as low. This can be seen from the initial assessment which shows only 2 out of 12 students who are able to master the entire concept. However, after using the VLab Plantae application has increased, seen from the final assessment that is 9 out of 12 students who are able to understand the entire concept after using the VLab Plantae application.

The use of the VLab Plantae application in the learning process can help students improve their understanding of the concept of plant growth and development material through four phases of the learning process. First, the introduction phase when students start using the application. Second, the acquisition phase, where they observe each step of plant change in the application. Third, the retention phase, which is the process of remembering the material. Fourth, the feedback phase to evaluate students' mastery of the concept. The VLab Plantae application helps students better understand the concept of plant growth and development material through the visualization shown in the Vlab Plantae application.

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