Plant Ecology Learning Modeling with Python Programming to Support Digital Argumentation Skills

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Abstract. The purpose of this research is to produce modelling in plant ecology courses based on python programming and to analyse whether the python programming model can encourage digital argumentation skills in problem-based learning through online learning. This research method uses research and development with ADDIE design (Analysis, Design, Development, Implementation, and Evaluation). Data collection techniques in this study are arguments written through tests taken from journals and student response questionnaires distributed after using the python programming application. The results of the preparation of modelling of plant ecology courses are arranged in a figma application in the form of a user experience based on a flow chart to match product features with user needs. The model design that has been compiled will be coded with the python programming language using visual studio code so that the code provided can be read by the system. The results of digital argumentation skills were carried out to 6 students with an average level of argumentation categories that varied, low (34%), moderate (50%), and high (16%). Small-scale trials using python resulted in an average percentage value of 94.66% which is included in the very good category and is feasible to use.

Keywords: Digital Argumentation · Plant Ecology · Problem Based Learning

1 Introduction

Learning in the era of the industrial revolution and the era of society as it is today requiring technological support, especially when electronic learning (E-Learning) is increasingly being used. Advances in technology have given rise to many innovative digital services on many types of platforms. Many studies of digital learning media have resulted in beneficial and dependable connectivity and interactions [1], and able to make students learn more independently [2]. The shift in the form of learning is undergoing a transformation with the integration of technology so that the learning process is not bound by space and time so that it can be done anywhere and anytime [3], and can be used to support any learning material.

Implementation of technology as a digital program in the form of coding that is popular and often used is Python. This Python program has advantages because it is

easy to use and can be applied to encourage students to think critically [4] and able to convey arguments well so that they can be identified for evaluation of the learning conditions experienced [5]. The development of python programming to support and make learning more interesting is very possible, as it can be applied in plant ecology lectures. The use of this python platform is unique because it is interesting so that it will encourage student motivation to learn better. The use of attractive digital platforms such as the python program also encourages innovation when used [6], as well as being able to become a way of learning to solve problems [7].

Biology learning materials including the discussion of ecology is a study that discusses the reciprocal relationship between inorganic and organic components. Thus, plant ecology is a branch of ecology that specifically studies the micro-interaction of a plant and its growth and development processes with its environment [8]. Making this plant ecological material more interesting by utilizing python programming is a challenge for researchers. Hope to encourage the emergence of logical and structured arguments as part of higher order thinking skills by students as the main users.

Scientific arguments with careful consideration and evidence that underlie students' analytical and critical thinking skills. [9, 10] shows that empowering argumentation skills by paying attention to evidence elements will have an impact on increasing students' understanding of concepts. But on the other hand, if the argument is only based on assumptions without providing evidence, it makes the students' understanding of concepts less than optimal. The facts in the lectures show that the average argumentation ability of students is still relatively low and they face difficulties in finding and using evidence to support the argumentative claims presented. Along with the integration of technology and the use of e-learning, the form of argumentation has changed to digital and is called digital argumentation (DA). Submission of DA is common in online learning.

Bringing up DA in lectures can be done by applying a problem concept related to the use of natural pesticides in controlling palawija plant pests in accordance with the Ecology material. By practicing presenting arguments through the e-learning platform by including evidence, it makes students more confident in providing explanations for scientific phenomena that occur in everyday life based on scientific theories and concepts [11].

The Python program, which is designed based on the theme of the Plant Ecology lecture, has the advantage of choosing reading references to help students understand the material as the basis for their thought processes. This is because the delivery of arguments must be based on an individual's understanding of the conditions at hand [12]. With the delivery of references as the basis for initial thinking, students have more detailed insight into the material discussed. Based on the problems presented, it is important to research and develop online learning systems to produce modeling in the python programming-based plant ecology course.

2   Method

The research was carried out at PGRI Madiun University (UNIPMA) with several stages, namely the analysis, design, development, implementation and evaluation stages in the odd semester of the 2022/2023 academic year. This research is a development research

or R&D (Research and Development) with reference to the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Research activities at each stage are described as follows; 1) the analysis was carried out by interviewing and observing the 6th semester students, 2) the design was carried out by compiling a python program based on plant ecology material, 3) development, carried out by media validation on an expert validator with the components being validated were: (a) software aspects, (b) aspects of learning media) and (c) the suitability of the device with learning. In addition, the development stage is also carried out with small-scale trials on students as the main users, 4) implementation is carried out with limited trials and 5) evaluation is carried out by revising and improving the python-based learning media products produced. Data analysis was carried out descriptively qualitatively at each stage.

3 Results and Discussion

The results of the development research conducted are as follows:

a. Analysis

    The results of interviews related to needs show that students still need learning media that are able to support understanding plant ecology material. 83% of students stated that it was difficult to convey arguments because of limited information and less study time. They stated that varied and technology-based learning media would help improve understanding of the material while achieving an optimal experience in terms of using technology.

b. Design

    The design of learning media programming for the Plant Ecology course begins with the preparation of product designs in the form of flow charts and user experiences, as follows:

    Figure 1 shows a schematic of a python programming application workflow. The design flow chart is used to help make product designs in the form of a design framework with results as shown in Fig. 2.

    Figure 2 shows the results of the python programming design starting with the main page for the user. The next page has a menu that you can choose to read scientific articles as a basis for helping students' initial understanding. One theme relates to the use of pesticides and their impact on cultivated crops. Students understand the content of the material from the article and then proceed with working on questions in the form of matching questions. At this stage, students make adjustments (by choosing) to determine the efficiency of certain pesticides on target crops. On the next page, a text assignment feature is developed to find out students' digital arguments (DA) for problems that have been provided through reading articles.

c. Development

    The results of the development stage based on media and content expert validators get results that are feasible and can be used. The revisions given as suggestions include the suitability of the questions to be more varied and emphasize problem solving. While the results of the development based on student responses when using the python programming application gave a positive response with a percentage of 94.66% in the "very good" category. User students provide suggestions for adding
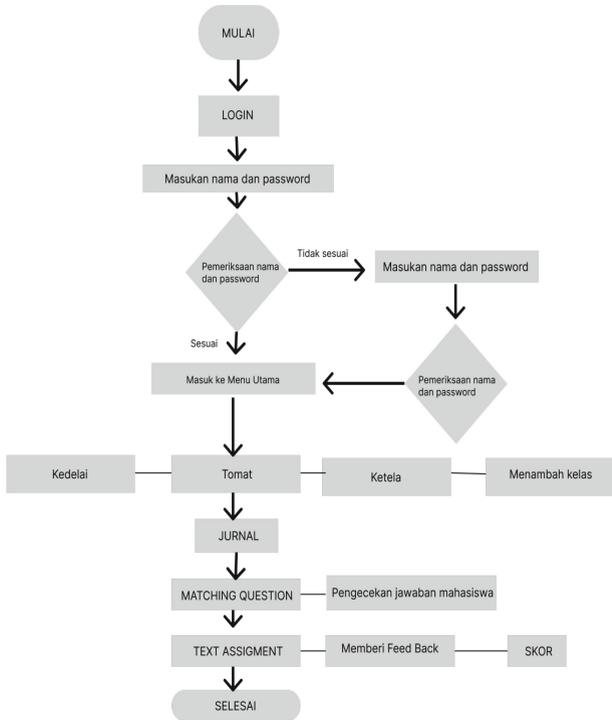
Fig. 1. Product design flowchart

variations to the types of readings or articles in order to get more complete information in accordance with the plant ecology material being discussed. As for the use of the python application, they claimed to be helped and happy with the application. The use of certain applications for the preparation of learning media has advantages in several ways, including:

The validator's responses in the form of criticism and suggestions can be used as the basis for revising learning media using python programming, giving a positive response of 89%. The validator assesses the learning media by filling out the validation sheet that has been given by the researcher in accordance with the development assessment criteria. Python programming learning media validated by expert validators is a summary of the results of quality analysis of all aspects of learning media.

d. Implementation

The implementation phase is carried out by taking the results of a problem-based learning test using the Python application to determine students' DA abilities. DA is delivered by students through online learning platforms in online discussion forums. The test results and students' DA abilities can be seen in Fig. 3.

Figure 3 shows that there is only 1 student who has DA ability in the high category or 16.66%. Students with moderate AD category were 3 students or 50% and students with low AD category were 2 students or 33.33%. Submission of DA by students is
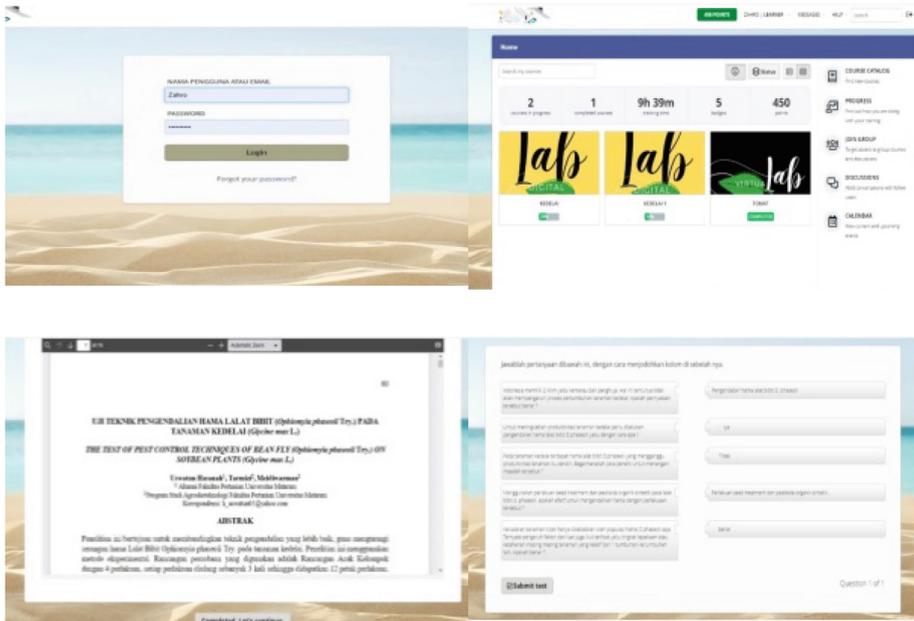
Fig. 2. The results of the python programming design for the plant ecology course

an effective and comprehensive strategy to help improve students' critical thinking skills [13, 14]. Submission of the results of thinking based on evidence in the form of arguments or submission of rebuttals to the arguments of friends in online discussion forums consciously develops students' critical thinking skills.

Arguments are statement that are supported by objective data and facts so that they can be used to change or influence the minds of others. While argumentation is the process of collecting various components needed to build an opinion (argument). Student responses based on digital argumentation (DA) on plant ecology courses through online learning using python programming are shown by student's ability to express, evidence for the arguments presented, linkage of evidence and arguments, quality of arguments, refutation, and logical thinking.

Figure 4 explains that students who have arguments with high categories provide claims of submitted arguments, evidence for the arguments presented, linkage of evidence and arguments, quality of arguments, rebuttals, and logical thinking well, which is aimed at the sentence "Regions with soil that are classified as sour, low organic C content, high N and P, low K and Mg, high Ca, high Al-dd. The average soil PH is 5.2 (classified as acidic)." students stated that there was evidence of arguments contained in the journal to state the reinforcement of the claims of their arguments and their connection with the evidence.

Based on Fig. 5, it can be seen that students who are said to have moderate argumentation skills in online learning in low plant botany courses can be seen from students being able to provide claims, evidence for the arguments presented, linkage of evidence and arguments, quality of arguments, refutation, and logical thinking. Quite
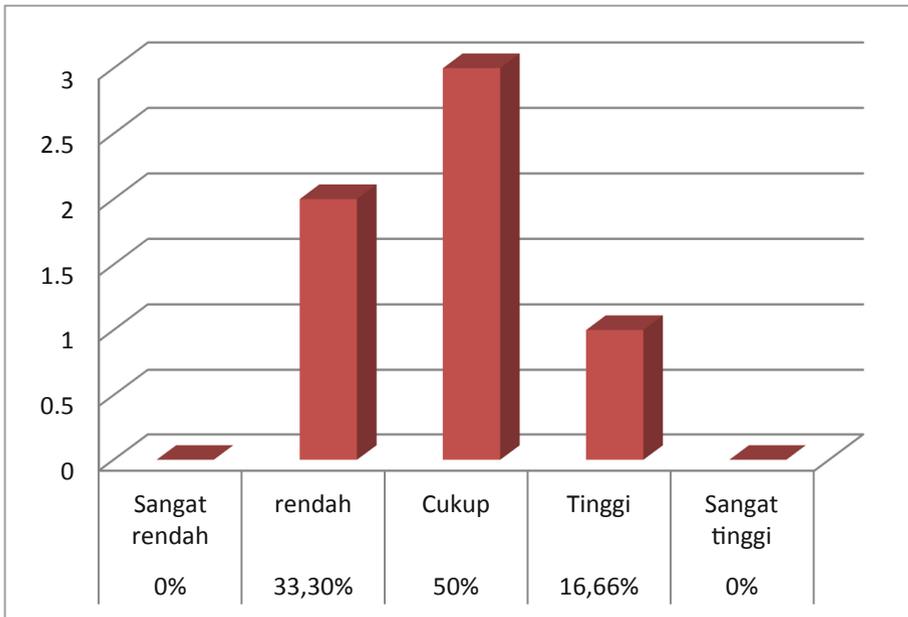
Fig. 3. DA ability of plant ecology course students by using learning media based on the results of python programming development

well although there are some that are still lacking, especially in terms of conveying the relationship between the evidence and the arguments expressed (Fig. 6).

Explained that students who have low argumentation skills in online learning based on python programming in plant ecology courses can be seen from students who provide claims, evidence for the arguments presented, linkage of evidence and arguments, quality of arguments, refutation, and logical thinking are still lacking, especially in terms of interrelationship of evidence and argument, quality of argument, refutation, and logical thinking. Low arguments usually cannot explain arguments with data obtained through relevant reference sources.
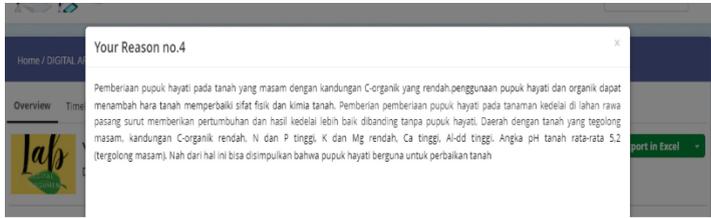
> Application of biological fertilizers on acidic soils with low organic C content, the use of biological fertilizers can add soil nutrients to improve soil properties and chemistry. The application of biofertilizers to soybeans in tidal swamp land provides better growth and yield of soybeans than without biofertilizers, Areas with acidic soil, low organic C-N and high P content, low K and Mg, high Ca, Ai- high dd. The average soil pH is 5.2 (classified as acidic). Well, from this it can be said that biological fertilizers are useful for soil improvement

> Pemberian pupuk hayati pada tanah yang masam dengan kandungan C-organik yang rendah penggunaan pupuk hayati dapat menambah hara tanah memperbaiki sifat sifat dan kimia tanah. Pemberian pupuk hayati pada tanaman kedelai di lahan rawa pasang surut memberikan pertumbuhan dan hasil kedelai lebih baik dibanding tanpa pupuk hayati, Daerah dengan tanah yang tergolong masam, kandungan C-organik rendah N dan P tinggi, K dan Mg remdah, Ca tinggi, Ai-dd tinggi. Angka PH tanah rata rata 5,2 (tergolong masam). Nah, dari hal ini bisa disimpulkan bahwa pupuk hayati berguna untuk perbaikan tanah

Fig. 4. Argument in high category

Evaluation

The evaluation stage is carried out to improve the results of developing learning models using python programming. Improvements based on suggestions from validators and students as related users when inputting personal data is needed. Simpler steps. Transfers and transfers from one question to another often have errors and this is corrected by adding a data storage area. Then also need improvement to delete cache or junk data that is no longer needed in the database.
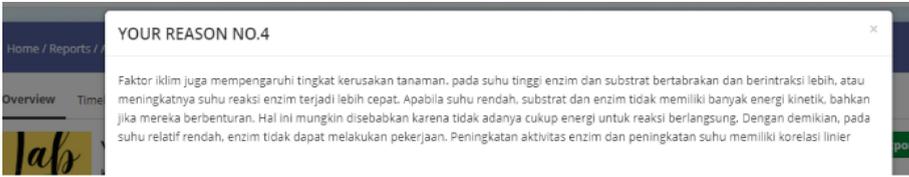
> Faktor iklim juga mempengaruhi tingkat kerusakan tanaman. Pada suhu tinggi enzim dan substrat bertabrakan dan berinteraksi lebih atau meningkatnya suhu reaksi enzim terjadi lebih cepat. Apabila suhu rendah, substrat dan enzim tidak memiliki banyak energi kinetik, bahkan jika mereka berbenturan. Hal ini mungkin disebabkan karena tidak adanya cukup energy untuk reaksi berlangsung. Dengan demikian, pada suhu relative rendah, enzim tidak dapat mengubah pekerjaan. Peningkatan aktivitas enzim dan peningkatan suhu memiliki korelasi linier

> Climatic factors also affect the level of crop damage. At high temperatures the enzyme and substrate collide and interact more or increase the temperature the enzyme reaction occurs faster. When the temperature is low, the substrate and enzyme do not have much kinetic energy, even if they collide. This may be because there is not enough energy for the reaction to take place. Thus, at relatively low temperatures, enzymes cannot change work. An increase in enzyme activity and an increase in temperature have a linear correlation

Fig. 5. Argument in medium category

> Terjadinya pengerasan tanah pada lading pertanian yang menyebabkan penurunan produktivitas tomat.

> The occurrence of soil hardening in agricultural fields which causes a decrease in tomato productivity.

Fig. 6. Argument in low category

4   Conclusion

The development of learning media by utilizing python programming for Plant Ecology courses has a positive impact on increasing student DA. Python programming is designed with scientific knowledge as a first step that encourages students to pay attention to important concepts related to the material. Large-scale trials using development results are still needed to get a more comprehensive picture of students' DA abilities as an important part of higher order thinking skills.

References

1. A. Klein, C. Sørensen, A. Sabino, D. Freitas, C. Drebes, and S. Elaluf-calderwood, "Technological Forecasting & Social Change Understanding controversies in digital platform innovation processes : The Google Glass case," *Technol. Forecast. Soc. Chang.*, vol. 152, no. December 2019, p. 119883, 2020, doi: https://doi.org/10.1016/j.techfore.2019.119883.
2. D. Górska, "E-learning in Higher Education," *Pers. Challenges.*, vol. 6, no. 2, p. 35, 2016, doi: https://doi.org/10.15633/pch.1868.
3. Y. Perbawaningsih, "Plus Minus of ICT Usage in Higher Education Students," *Procedia - Soc. Behav. Sci.*, vol. 103, pp. 717–724, 2013, doi: https://doi.org/10.1016/j.sbspro.2013.10.392.
4. A. Nkata, "Application of Python Programming to Convert Tanzanian Schools Textbooks into Audiobooks to Maximize the Learning Time of Students of the Day Schools Application of Python Programming to Convert Tanzanian Schools Textbooks into Audiobooks to Maximize the," *Acta Sci. Comput. Sci.*, vol. 4, no. January 2022, pp. 1–5, 2022.
5. M. Lukitasari, R. Ristanti, J. Handhika, W. Murtafiah, A. Sukri, and R. Hasan, "Identification of Student's Critical Thinking Skills on Cryptogamic Based on Digital Argumentation Performance through Online Learning," *Proc. 2nd Int. Conf. Educ. Technol. (ICETECH 2021)*, vol. 630, no. Icetech 2021, pp. 414–419, 2022, doi: https://doi.org/10.2991/assehr.k.220103.060.
6. A. Klein, C. Sørensen, A. S. de Freitas, C. D. Pedron, and S. Elaluf-Calderwood, "Understanding controversies in digital platform innovation processes: The Google Glass case," *Technol. Forecast. Soc. Change*, vol. 152, no. June 2019, p. 119883, 2020, doi: https://doi.org/10.1016/j.techfore.2019.119883.
7. M. Namratha, G. S. Rekha, S. Akram, S. Selva Kumar, and J. S. Nayak, "Active learning approach for python programming," *J. Eng. Educ. Transform.*, vol. 32, no. 1, pp. 15–19, 2018.
8. S. Rasidi, "Batasan dan Ruang Lingkup Ekologi Tumbuhan," in *Ekologi Tumbuhan*, vol. 1927, 2008, pp. 1–31.
9. V. Viyanti, C. Cari, W. Sunarno, and Z. Kun Prasetyo, "Pemberdayaan Keterampilan Argumentasi Mendorong Pemahaman Konsep Siswa," *J. Penelit. Pembelajaran Fis.*, vol. 7, no. 1, pp. 43–48, 2016, doi: https://doi.org/10.26877/jp2f.v7i1.1152.
10. M. Lukitasari, J. Handika, W. Murtafiah, and A. R. Nurhikmawati, "Examining students' Self-Assessment of Digital Argumentation (SADA) in e-biology class: A Rasch analysis," *JPBI (Jurnal Pendidik. Biol. Indones.*, vol. 6, no. 2, pp. 209–216, Jul. 2020, doi: https://doi.org/10.22219/JPBI.V6I2.11919.

11. M. Genc, "The project-based learning approach in environmental education," *Int. Res. Geogr. Environ. Educ.*, vol. 24, no. 2, pp. 105–117, 2015, doi: https://doi.org/10.1080/10382046.2014.993169.

12. L. Lehti and J. Kallio, "Participation in an online social policy discussion: Arguments in focus," *Discourse, Context Media*, vol. 19, pp. 58–65, 2017, doi: https://doi.org/10.1016/j.dcm.2017.02.005.

13. M. Tengberg and C. Olin-Scheller, "Developing Critical Reading of Argumentative Text: Effects of a Comprehension Strategy Intervention," *J. Lang. Teach. Res.*, vol. 7, no. 4, p. 635, 2016, doi: https://doi.org/10.17507/jltr.0704.02.

14. J. A. Bulgren, J. D. Ellis, and J. G. Marquis, "The Use and Effectiveness of an Argumentation and Evaluation Intervention in Science Classes," *J. Sci. Educ. Technol.*, vol. 23, no. 1, pp. 82–97, 2014, doi: https://doi.org/10.1007/s10956-013-9452-x.