Journal of Engineering Science and Technology
Special Issue on ICMScE2022, June (2022) 33 - 41

WEB INQUIRY ENVIRONMENT: A MEDIUM LEARNING SCIENCE

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Abstract

The investigation carried out in the post-covid era uses a web inquiry environment in science learning as a learning resolution through contextual learning. The purpose of this study was to identify students' inquiry abilities through an intermediary web inquiry environment, which had been previously tested by experts. 53 junior high school students were involved in seven phases of inquiry activity, starting from making research questions, hypothesizing, designing and conducting experiments, collecting and analyzing data to communicating the results. Each phase relates to the other using a teacher-led information stimulus on the theme of plant growth. The highest yields were obtained in two inquiry phases of >60%, namely the problem formulation phase and the experiment phase. The rest of the students' inquiry abilities are still low because they are not used to inquiry and learning technology. Web-based inquiry learning continues to evolve following changes to be used as a science learning solution.

Keywords: Inquiry abilities, Science learning, Web inquiry environment

1. Introduction

The use of web-based technology provides a new type of support for inquiry learning [1]. The support includes tools for synthesizing, sharing ideas, visualizing data, and offering knowledge integration [2, 3]. If properly designed, web support encourages classroom learning by adding information based on teacher direction. Web intermediaries are not a problem in science learning with inquiry, instead. Instead, online platform-based learning supports direct inquiry activities to help students carry out relevant activities [4]. Students are guided through exploring science phenomena to become independent learners by maximizing knowledge [5]. The Web provides a solution where teachers engage students in scientific investigations through simple, realistic experiments. It emphasizes the use of inquiry to evaluate evidence and construct knowledge critically [6]. In addition, the web is not only an effective collaborative inquiry but benefits the implementation time and narrows the gap between male and female students to develop confidence in learning science [7]. The use of technology is not entirely able to replace direct inquiry skills because teaching expressive skills when conducting experiments leads students to a deeper understanding of the concepts being discussed [8]. The implementation combines inquiry learning in the classroom [9].

We showed the web is e-learning to facilitate an appropriate online science environment. The web inquiry environment is divided into two, the teacher room and the student class. The teacher's room is made for the subject teacher to set up the material, virtual lab, and mark and give feedback on students' work. Student classes allow students to access the specific type, test the virtual experiment, and fill in the answer. Therefore, the focus of this study investigates the position of the web inquiry environment as an intermediary combined with direct inquiry learning, based on a discourse stimulus that contains an investigation of plant growth where students can experiment at home.

2. Literature Review

Plants need light and water to gain mass [10]. In photosynthesis, plants use light energy to convert carbon dioxide and water into simple sugars. These sugars are linked into more complex molecules to form leaves, stems, and roots. Without sufficient light and moisture, plants cannot gain mass. The plant growth model was calibrated with experiments by students (see Fig. 1). Plants grown in dim light may grow taller than plants grown in adequate light, although they will gain less mass and have smaller leaves [11]. Plants shaded by other plants will have a better chance of reaching sunlight if they grow tall quickly. Fertilizers significantly accelerate plant growth as they provide large amounts of nutrients to plants. Compost has a less dramatic effect, but it also promotes plant growth by providing small amounts of nutrients and improving soil structure [12]. Excessive watering causes losses as large as water shortages [13]. Plant roots need oxygen and rot if they are constantly saturated with water. Students can study the needs of plants used in designing and conducting controlled experiments, where every variable except the tested variable is kept constant.

3.Methods

The study was a one-shot case study investigating the inquiry abilities of 53 high school students, the total number of students represented in 13 groups. The material

displayed in the problem discourse contains stimulus information in the form of the theme of plant tissue transportation. Quantitative calculations also explain which inquiry phase does not meet the criteria for further analysis. This inquiry-based web provides an online learning platform and acquires a guided inquiry model for students by presenting topics with discourse stimuli for inquiry students [14]. It is also accessible using a web inquiry environment (see Fig. 2). Based on the web shown in Fig. 2, there are sections students and teachers can access. Previously, students first created an account to access the class code provided by the teacher as a learning provider. Thus, this web inquiry environment aims to help students engage in inquiry learning about scientific phenomena that are difficult to teach using only textbooks and demonstrating science experiments.

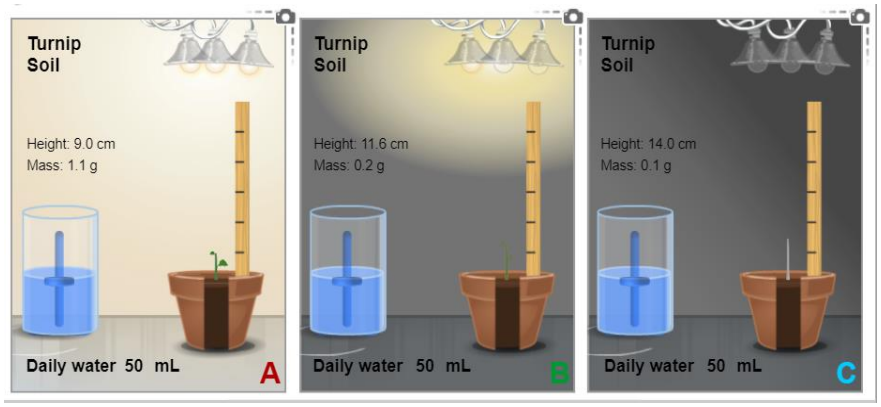

Fig. 1. Testing the effect of plant growth. This figure was adapted from https://gizmos.explorelearning.com on 15 August 2022.

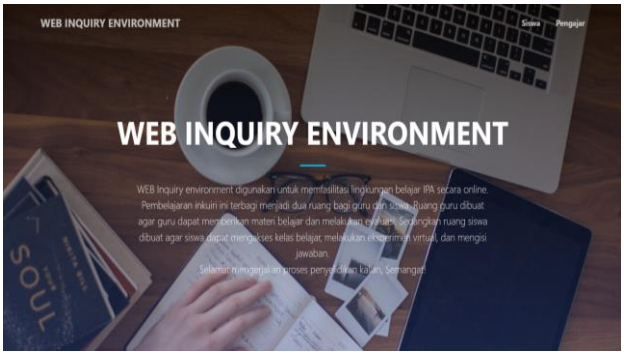

Fig. 2. The inquiry environment web view. This figure was adapted from http://belajarinkuiri.id/ on 16 August 2022.

4. Results and Discussion

The use of the web allows authentic collaboration to connect using interactive discussions. Therefore, the teacher's role is needed as a learning support provider to better plan independent activities students will do. Although it is a challenge for teachers to become web-based learning designers, the systems that exist on the web assist in designing epistemologically appropriate designs [15]. The web-based

inquiry used to identify the phenomenon of scientific investigation further supports online teaching for students and teachers in monitoring learning progress [16]. Therefore, users can be combined with other technology tools to create a learning environment that better meets students' needs. Understanding using a web inquiry environment, this research activity is described as summarized in Fig. 3.

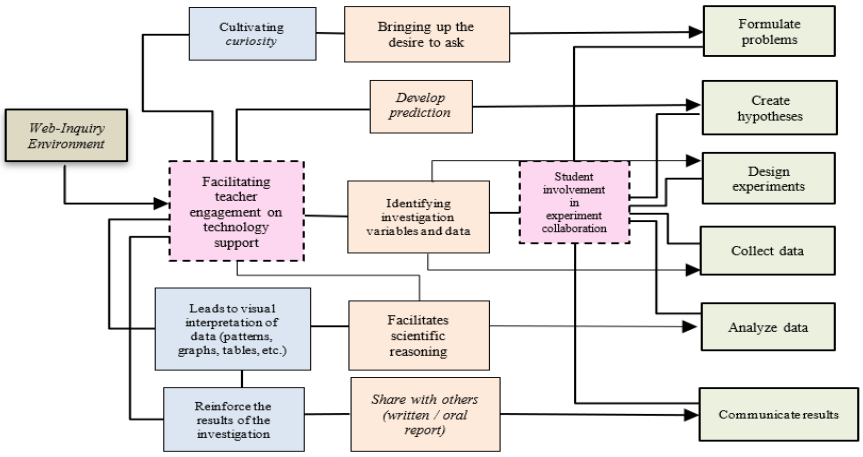

Fig. 3. Design inquiry activities in a web inquiry environment.

Seven phases of achievement are available in a web inquiry environment, starting with students understanding the content of the discourse with an information stimulus the teacher guides. Students are directed to make research questions. Curiosity is needed as students' initial ability. Students write hypotheses in the available columns based on the discourses they have understood before; the aim is to build predictions. Students are asked to upload a design sketch as an image made based on the investigation plan. According to the provisions, students work together to carry out simple experiments at home on the investigation theme, and collaboration is needed within the group. Then require students to upload observation tables as evidence of the data collection process. Students strengthen experimental analysis with a virtual lab that supports reasoning against the results of the investigation. Finally, students answer the conclusion questions by explaining the findings scientifically.

This study used a discourse containing an inquiry as an information stimulus given by the teacher to a group of students on the theme of plant tissue transportation. The connection between phases in inquiry activities is crucial; the highest gains are in formulating problems and conducting experiments. The following is a discourse of information: "*A student prepares two water henna plants, with stems of the same size and length, and then washes the roots. Each plant was placed in a measuring cup containing 200 ml of coloured liquid and labelled A and B. Measuring cup A was placed in a place exposed to direct sunlight, and the measuring cup B was placed in a place not exposed to sunlight, then both were observed for 15 minutes".* Through student inquiry activities with a web inquiry environment, the results of achieving student inquiry abilities are shown in Fig. 4.

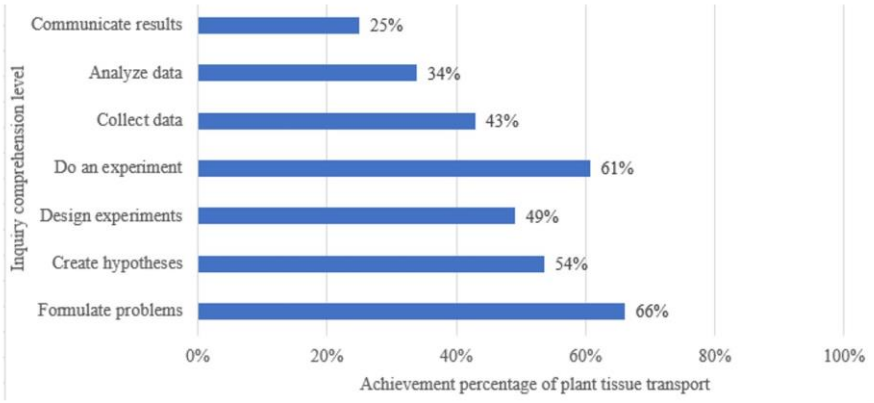

Fig. 4. Student inquiry ability results.

The discourse displayed on the inquiry environment web is about *the effect of plant tissue transportation on the stems of water henna plants on light intensity in different places.* Entering the problem formulation activity, groups of students are required to make a research question *"Does the intensity of sunlight affect the height of the coloured liquid between glass A and B?".* This example answer is appropriate because it provides a keyword on the effect of light intensity and liquid level in the two glasses being compared. This activity indicates the direction in which students are already thinking about a particular theoretical area [17].

In addition, the ability to ask questions is formed because of the habit of answering or not daring to be different [18]. Thus, the emergence of questions becomes a key to inquiry in understanding scientific concepts and representing a person's way of thinking to continue learning [19].

The hypothesis generation phase has a lower percentage gain of 54%. Students have difficulty finding the correct variable to state an idea that can be tested. Likewise, in the experimental design phase, the web requires students to upload design sketches based on the information provided. Still, students' understanding of predicting predictions when making hypotheses cannot be adequately translated. It affects their thinking ideas [20].

An example of a sketch made by a group of students is shown in Fig. 5. Figure 5 does not indicate the height of the colour liquid and the influence of sunlight on the two plants in different places. On the other hand, the image's meaning differs in the experiment's phase, a simple experimental video at home based on the discourse of the information stimulus.

The investigation conducted by the sample group of students synthesized synthesis procedures to fulfil the data collection design [21]. This requires a balance between knowledge and skills to create a systematic observation step and enable students to communicate the results scientifically [22].

Furthermore, the impact of the experimenting phase on the data collection phase required students to present the data in tabular form, but it could not be realized. This is because the understanding of the data to interpret the data in both quantitative and qualitative formats has not been fulfilled [23].

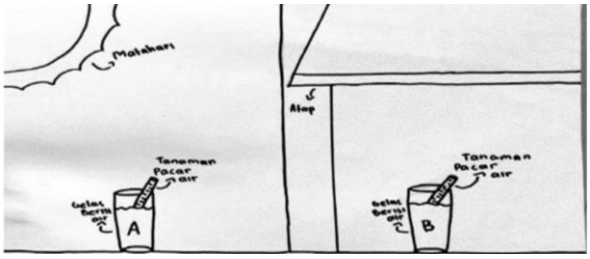

Fig 5. Plant transportation drawing sketch design.

The data analysis phase accommodates the virtual lab to strengthen students' concept mastery. This phase directs students to collect data from the results of the investigation. With the process of collecting data on graphs, students are expected to be able to interpret the explanations made. However, the ability to analyze the data in Fig. 3 only obtained at 34%. The group of students has difficulties in making and translating the investigation results even though the data presented on the web should be able to be visualized clearly. This indication arises because students have difficulties relating graphs to evidence that leads to scientific arguments [24]. The low data analysis is caused by students not being able to read the chart of the experimental results, causing errors, and the explanations given by students are not on the results of the data. For this reason, students need to be involved in reflecting on changes in knowledge [25].

The phase of communicating the results of the score is only 25% and is the lowest phase because previously, students were judged not to have solid scientific arguments, and the findings obtained were not able to be criticized by them [26]. Based on the overall results of the inquiry ability, it indicates that students have not been able to test hypotheses and translate data from investigation activities. In addition to low concept mastery skills, students are not accustomed to giving arguments according to the investigation stages, so the scientific communication conveyed looks inadequate [27]. In addition, the use of the web, which is more technologically advanced, as an intermediary for learning cannot be appropriately applied [28]. The planning teachers and students should have been prepared when attending an inquiry class. Both of them can take part in starting learning activities in web classes. This, of course, overcomes the excess of time to explore the use of the web combined with direct inquiry learning. The results from implementing the inquiry process can be maximized. This study is in line with previous studies regarding the use of web for improving students understanding [29-33]. This study also confirms the effectiveness of additional teaching media to support and increase students' understanding [34-40].

5. Conclusion

Data acquisition shows that students are not used to the inquiry, so understanding content is challenging to translate into scientific explanations. Inquiry capabilities do not yet have more exploration when directed to carry out investigations of plant tissue transportation. Students have not been able to prove that the amount of light does not affect height growth. In comparison, the amount of light affects plant mass depending on the type of fertilizer and the amount of water applied. The teacher's attention is needed to use a web inquiry environment that students have not fully

mastered. Thus, the combination of direct inquiry with the web has a planned readiness before starting the investigation class.

References

1. Bodzin, A.M.; and Cates, W.M. (2003). Enhancing preservice teachers' understanding of web-based scientific inquiry. *Journal of Science Teacher Education*, 14(4), 237-257.
2. Dewi, P.S.; Widodo, A.; Rochintaniawati, D.; and Prima, E.C. (2021). Web-based inquiry in science learning: Bibliometric analysis. *Indonesian Journal of Science and Mathematics Education*, 4(2), 191-203.
3. Dewi, P.S.; Rochintaniawati, D.; and Siahaan, P. (2020). Profiling the context of natural history teacher candidate for the elementary school degree through web-based inquiry. *Jurnal Inovasi Pendidikan IPA*, 6(1), 49-58.
4. Kuang, X.; Eysink, T.H.; and de Jong, T. (2020). Effects of providing partial hypotheses as a support for simulation-based inquiry learning. *Journal of Computer Assisted Learning*, 36(4), 487-501.
5. Cooper, A.C.; Southard, K.M.; Osness, J.B.; and Bolger, M.S. (2022). The instructor's role in a model-based inquiry laboratory: Characterizing instructor supports and intentions in teaching authentic scientific practices. *CBE—Life Sciences Education*, 21(1), 1-19.
6. Bodzin, A.M. (2005). Implementing web-based scientific inquiry in preservice science methods courses. *Contemporary Issues in Technology and Teacher Education*, 5(1), 50–65.
7. Raes, A.; Schellens, T.; and de Wever, B. (2014). Web-based collaborative inquiry to bridge gaps in secondary science education. *Journal of the Learning Sciences*, 23(3), 316-347.
8. Duran, M.; and Dökme, I. (2016). The effect of the inquiry-based learning approach on student's critical-thinking skills. *Eurasia Journal of Mathematics Science and Technology Education*, 12(12), 2887-2908.
9. Donohue, K.; Buck, G.A.; and Akerson, V. (2020). Where's the science? Exploring a new science teacher educator's theoretical and practical understandings of scientific inquiry. *International Journal of Research in Education and Science*, 6(1), 1-13.
10. Manullang, T. I. B.; Nandiyanto, A. B. D.; Suryadi, A.; Rochyadi, E.; Haerudin, D.; Muspita, R.; Sumiroh, E.; and Manullang, L. S. (2021). Improving students with intellectual disabilities science process skills through photosynthesis experiment in enhancing climate change awareness. *Journal of Engineering Science and Technology*, 16(3), 2368-2377.
11. Reich, P.B. (2014). The world-wide 'fast–slow'plant economics spectrum: a traits manifesto. *Journal of Ecology*, 102(2), 275-301.
12. Elshony, M.; Farid, I.M.; Alkamar, F.; Abbas, M.H.; and Abbas, H. (2019). Ameliorating a sandy soil using biochar and compost amendments and their implications as slow release fertilizers on plant growth. *Egyptian Journal of Soil Science*, 59(4), 305-322.
13. Wagg, C.; Hann, S.; Kupriyanovich, Y.; and Li, S. (2021). Timing of short period water stress determines potato plant growth, yield and tuber quality. *Agricultural Water Management*, 247, 1-10.

14. Sekarningsih, F.; Budiman, A.; and Gustiaji, G.R. (2021). Wix web-based dance learning media to support teaching in the pandemic era in high school. *Harmonia: Journal of Arts Research and Education*, 21(1), 178-191.
15. Raes, A.; Schellens, T.; De Wever, B.; and Vanderhoven, E. (2012). Scaffolding information problem solving in web-based collaborative inquiry learning. *Computers and Education*, 59(1), 82-94.
16. Gerard, L.F.; Ryoo, K.; McElhaney, K.W.; Liu, O.L.; Rafferty, A.N.; and Linn, M.C. (2016). Automated guidance for student inquiry. *Journal of Educational Psychology*, 108(1), 60-81.
17. Hu, W.; Wu, B.; Jia, X.; Yi, X.; Duan, C.; Meyer, W.; and Kaufman, J.C. (2013). Increasing students' scientific creativity: The "learn to think" intervention program. *The Journal of Creative Behavior*, 47(1), 3-21.
18. Zrada, M.; Kastens, K.A.; and Turrin, M. (2019). How to help your students ask more and better questions. *Oceanography*, 32(4), 204-206.
19. Wilhelm, P.; Beishuizen, J.J.; and Van Rijn, H. (2005). Studying inquiry learning with FILE. *Computers in Human Behavior*, 21(6), 933-943.
20. Wolff, A.; Wermelinger, M.; and Petre, M. (2019). Exploring design principles for data literacy activities to support children's inquiries from complex data. *International Journal of Human-Computer Studies*, 129, 41-54.
21. Sengupta, P.; Kinnebrew, J.S.; Basu, S.; Biswas, G.; and Clark, D. (2013). Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework. *Education and Information Technologies*, 18(2), 351-380.
22. Pangrazio, L.; and Sefton-Green, J. (2020). The social utility of 'data literacy'. *Learning, Media and Technology*, 45(2), 208-220.
23. Lai, K.; Cabrera, J.; Vitale, J.M.; Madhok, J.; Tinker, R.; and Linn, M.C. (2016). Measuring graph comprehension, critique, and construction in science. *Journal of Science Education and Technology*, 25(4), 665-681.
24. Lazonder, A.W.; and Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research*, 86(3), 681-718.
25. Kim, H.J.; Miller, H.R.; Herbert, B.; Pedersen, S.; and Loving, C. (2012). Using a wiki in a scientist-teacher professional learning community: Impact on teacher perception changes. *Journal of Science Education and Technology*, 21(4), 440-452.
26. Schmid, S. (2015). Does inquiry-learning support long-term knowledge retention?. *International Journal of Learning, Teaching and Educational Research*, 10(4), 51–70.
27. Garza, E.; and Cavazos, L. (2020). Shifting to an outdoor learning space: Embracing nature to support science process skills for English learners. *Journal of the World Federation of Associations of Teacher Education*, 3(3), 32-49.
28. Susetyo, B.; Maryanti, R.; and Siswaningsih, W. (2021). Students with hearing impairments' comprehension level towards the exam questions of natural science lessons. *Journal of Engineering Science and Technology*, 16(2), 1825-1836.
29. Nuhu, K. M.; and Onojah, A. O. (2022). Effect of webinar multimedia platform on students' academic performance in selected educational technology

concepts in University of Ilorin. *Indonesian Journal of Multidiciplinary Research,* 2*(*1), 9-20.

30. Sumitra, I. D.; Wirawan, E.; Putra, M.; Kusumaningrat, I.; and Maulana, H. (2021). Design of webinar information system for people with hearing impairments. *Indonesian Journal of Community and Special Needs Education,* 1(2), 77-86.
31. Soegoto, E. S.; Ramana, J. M.; and Rafif, L. S. (2021). Designing an educational website regarding recycling of plastic waste into roads. *ASEAN Journal of Science and Engineering Education,* 2(1), 135-140.
32. Nugraha, M. G. (2023). Development of web-based radioactivity teaching materials oriented-on character education for high school students. *ASEAN Journal of Science and Engineering Education*, 3(1), 95-102.
33. Hartati, A.D.; Maryanti, R.; Azizah, N.N.; Al Husaeni, D.F.; Wulandary, V.; Irawan, A.R. (2023). Webtoon comic media to improve reading comprehensions for students with hearing impairment in special primary schools. *ASEAN Journal of Community and Special Needs Education*, 2(1), 9-16
34. Malaguial, P. A.; Maggay, A. K.; Van Sibugan, B.; Salaban, Q.; and Abusama, H. (2021). Classroom experiments using phytochemical analysis of weed (eleusine indica). *Indonesian Journal of Multidiciplinary Research,* 1(2), 325-328.
35. Putri, S. R.; Hofifah, S. N.; Girsang, G. C. S.; and Nandiyanto, A. B. D. (2022). How to identify misconception using certainty of response index (cri): A study case of mathematical chemistry subject by experimental demonstration of adsorption. *Indonesian Journal of Multidiciplinary Research*, 2*(*1), 143-158.
36. Apriyanti, V. P. (2023). Learning abilities of students with intellectual disabilities for cooking Indonesian traditional food "opak bakar": From step by step experiment to the analysis. *Indonesian Journal of Community and Special Needs Education,* 3(1). 43-54.
37. Bugarso, J. M. S.; Cabantugan, R. E.; Que-ann, D. T.; and Malaco, A. C. (2021). Students' learning experiences and preference in performing science experiments using hands-on and virtual laboratory. *Indonesian Journal of Teaching in Scienc*e, 1(2), 147-152.
38. Sungwiset, S.; Janprung, T.; Pechsiri, T.; and Puengsungewan S. (2021). Study of LED grow light driver circuit for indoor strawberry cultures: A class experiment. *ASEAN Journal of Science and Engineering Education,* 1(1), 21-30.
39. Rahmat, A. (2021). Simple experiments for introducing science to elementary school students. *ASEAN Journal of Science and Engineering Education,* 1(1), 73-78.
40. Manullang, T.I.B.; Nandiyanto, A.B.D.; Suryadi, A.; Rochyadi, E.; Haerudin, D.; Muspita, R.;, Sumiroh, E.; and Manullang, L.S. (2021) Improving students with intellectual disabilities science process skills through photosynthesis experiment in enhancing climate change awareness *Journal of Engineering Science and Technology,* 16(3), 2368-2377.