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How are problem-solving skills equipped in learning biodiversity? The efforts to realize learning of society 5.0

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ABSTRACT

Problem-solving skills and the ability to live sustainably by maintaining the harmonization of the environment/biodiversity are some of the characteristics of Society 5.0. Efforts to apply these characteristics need to be realized in biodiversity studies at universities. Currently, information about these efforts needs to be reviewed to develop efforts to equip skills which directly useful to solve problems in society. The study's aim described various efforts to equip problem-solving skills in biodiversity learning to realize learning of Society 5.0. The research method was descriptive and the respondents were lecturers who teach biodiversity subjects (n = 82) at various colleges in Indonesia (n = 38). The instrument was a questionnaire in Google form that contained questions about problem-solving skills. The data were analysed descriptively using Microsoft Excel version 2019. The results showed 98.8% of respondents had equipped problem-solving skills to their students. Regarding new literacy, 68.3% of respondents said they know and apply it in many ways in lecture activities. The conclusion This study concluded that various efforts had been made in biodiversity learning in colleges in equipping problem-solving skills as learning society 5.0. Lecturers need to increase skills of new literacy that support the implementation of learning of society 5.0. In the future, problem solving skills by integrating new literacy can become a necessity to be applied in more various universities.

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INTRODUCTION

Society 5.0 is a human-centered society, economic progress is balanced with solving social problems that are integrated with physical space and cyberspace systems that take advantage of developing science, technology, and innovation. The concept of society 5.0 by the objectives of the United Nations in realizing the Sustainable Development Goals (SGD), namely harmony and welfare community, poverty ended, environment, nature or biodiversity protected (Fukuda, 2020; Fukuyama. Mayumi, 2018; Salgues, 2018; Shiroishi, Uchiyama, & Suzuki, 2018). Problem-solving skills and the ability to live sustainably by maintaining the harmonization of the environment/biodiversity are some of the characteristics of society 5.0. It should be equipped in biodiversity learning in college as part of the 21st-century competencies provided. The efforts to apply these characteristics need to be realized in biodiversity studies at universities. The student-centered teaching and learning methods that develop experiential learning skills in a real environment are at the core of biodiversity education (Yli-Panula, Jeronen, Lemmetty, & Pauna, 2018).

Research on problem-solving skills as part of the competency of the 21st century including the Higher Order Thinking Skills (HOTS) as well had much to apply (Alkhatib, 2019; Amanda, Sumitro, & Lestari, 2021; Häkkinen et al., 2017; Silitonga, Panjaitan, & Supriyati, 2020; Zaharin, Sharif, & Mariappan, 2018). Study about biology student teachers' perception about biodiversity problem-solving skills related to the study of society 5.0. indicated the majority of students claimed they had done the problem-solving skills in their learning activities. This study recommends that in facing society 5.0 one of the efforts needed is to equip students with problem-solving skills by integrating new literacy (Faizah, Nuryani, Ambarwati, & Rahayu, 2021). The new literacy consists of 1) data literacy; 2) technological literacy ; 3) human literacy (Aoun, 2017). Several studies had made efforts to implement new literacy in learning activities and have received positive responses from students. Students get benefits that help them learn about real things in life (Anthonysamy, Koo, & Hew, 2020; Prasetya, A. T., Cahyono, E., Haryani, S., 2020; Rahmiwati, Festiyed, & Ratnawulan, 2020).

Currently, information about these efforts needs to be reviewed to develop better learning efforts to equip students with skills which application is useful directly to solve problems in society. Moreover, the previous research has used students as respondents (Faizah et al., 2021), that needs to be followed up with research that uses lecturers as respondents. The urgency of this research is to provide information that helps to carry out debriefing on new literacy to students because this needs to be done to prepare them to compete in an era that requires skills to adapt to technology that continues to develop. The novelty of this research is to map the implementation of new literacy by lecturers in learning activities so that it can be used to improve the curriculum in universities. The purpose of the study described various efforts to equip problem-solving skills in biodiversity learning to realize learning of society 5.0 by lecturers. The information obtained is expected to complement the previous data and can develop efforts to equip skills which directly useful to solve problems in society.

METHODS

Research Design

This study used a qualitative approach with a narrative research design. It described the respondent's information/opinions with the result that the respondent's views on the topic under study were obtained. While the type of data collected was data from a questionnaire from open questions (see Appendix 1). This study described various efforts to equip problem-solving skills in biodiversity learning to realize learning of society 5.0 by lecturers. This research was conducted from March to June 2021.

Population and Samples

The population used in this study were respondents from 38 universities in Indonesia Indonesia (state and private universities). Sampling was carried out by purposive sampling with lecturers as the research subject. The criteria of it, lecturers who giving lectures on biodiversity studies in their majors involving biology study programs, biology education study programs, science study programs, or science education study programs. This study obtained 82 appropriate respondents from 38 universities.

Instrument

The instrument was a questionnaire distributed via WhatsApp in Google form format (see Appendix 1). There were five things that are asked in the questionnaire with the following description: 1) Identity of Respondents (six questions), 2) Study of Biodiversity in Lectures (two questions), 3) Problem-Solving Skills in Lectures (nine questions), 4) New Literacy (six questions), 5) iNaturalist App (four questions). There were some questions with yes and no answers. A dichotomous scale type was used in the questionnaire. It is a two-point scale that presents options that are absolutely opposite each other, yes and no. This type of response scale does not give the respondent an opportunity to be neutral on his answer to a question.

The instruments questions in the questionnaire refer to the indicators of problem-solving skills in biodiversity study lectures by applying a problem-solving stage consisting of 1) Exploring and understanding, 2) Representing and formulating, 3) Planning and executing, 4) Monitoring and reflecting (OECD, 2017a). There were

also open questions about the implementation of new literacy which consists of 1) data literacy; 2) technological literacy; 3) human literacy as efforts of the lecturer's implement of Society 5.0. learning. Instrument validation was used expert judgment.

Procedure

The data collection procedure was implemented in five steps (Creswell, 2015) (Figure 1). It consisted of Step 1. Sampling approaches to selecting participants and sites; Step 2. Permissions required to gain access; Step 3. Determine the type of qualitative data to collect; Step 4. Develop procedures for recording data; Step 5. Manage and anticipating field issues and ethical considerations in data collection.

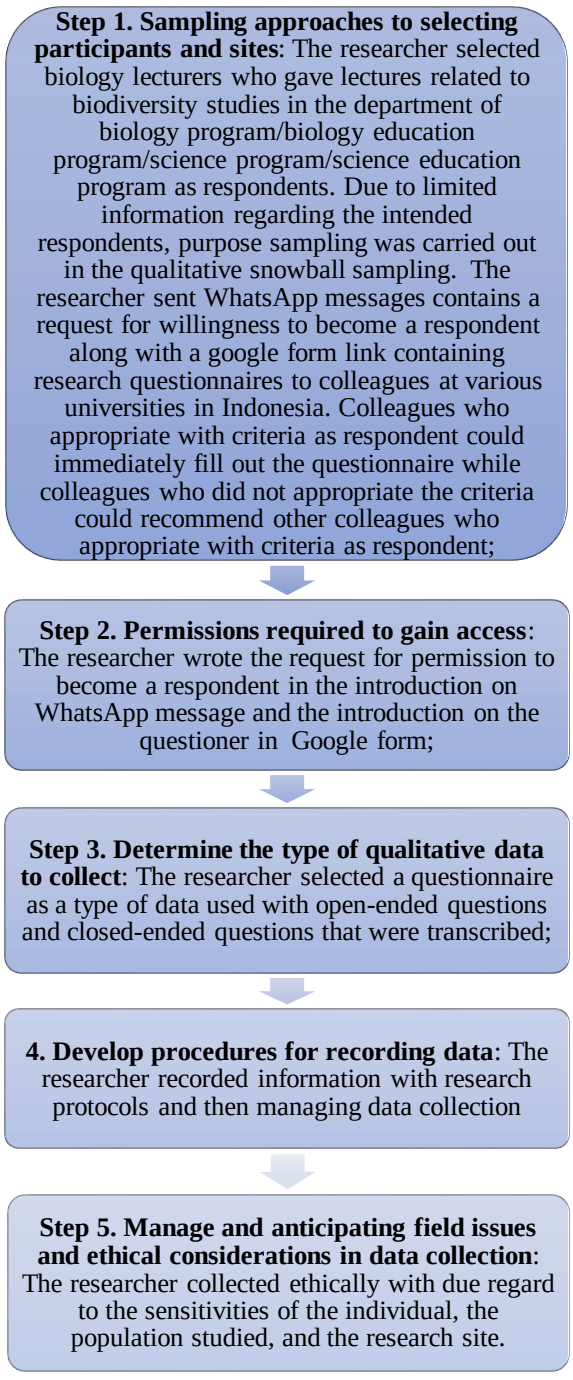

Figure 1. The data collection procedure (Creswell, 2015)

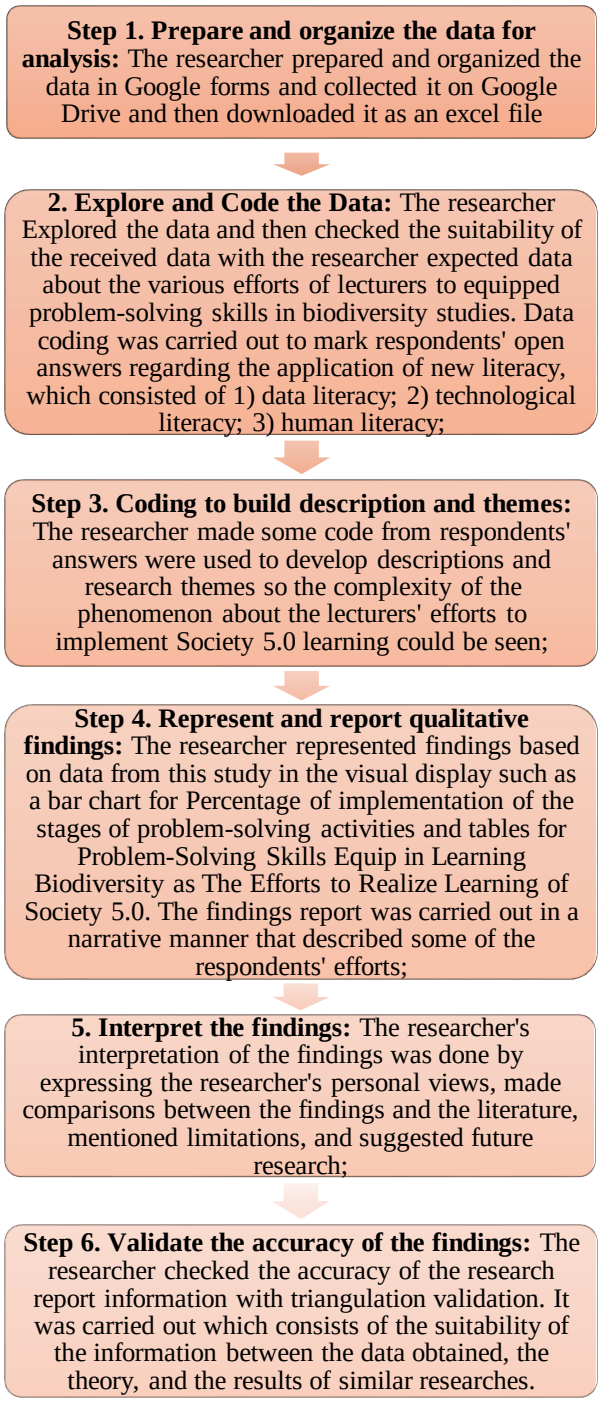

Figure 2. The data analysis techniques **(**Creswell, 2015)

Data Analysis Techniques

The data analysis techniques was implemented in five steps (Creswell, 2015) (Figure 2). It involved of Step 1. Prepare and organize the data for analysis; Step 2. Explore and Code the Data; Step 3. Coding to build description and themes; Step 4. Represent and report qualitative findings; Step 5. Interpret the findings. The data were analysed descriptively using Microsoft Excel version 2019, frequency and bar chart were used for summarized the data. Calculation of the percentage used the formula = (number of respondents with answer according to statement or a positive response : total respondents (n = 82) : 100%.

RESULTS AND DISCUSSION

The data were collected from 38 university and total of 82 lecturers participated in this study. Among all of respondents, study program majority were 58.5% from Biology and 36.6% from Education Biology, and the rest from science 2.4% and 2.4% science education. The study results indicated that 98.8% of respondents had equipped problem-solving skills and 64.6% of respondents equipped it through weekly practice activities and project assignment activities. Data about the stages of the problem-solving skills in lecture activities carried out by the respondents is shown in Figure 3.

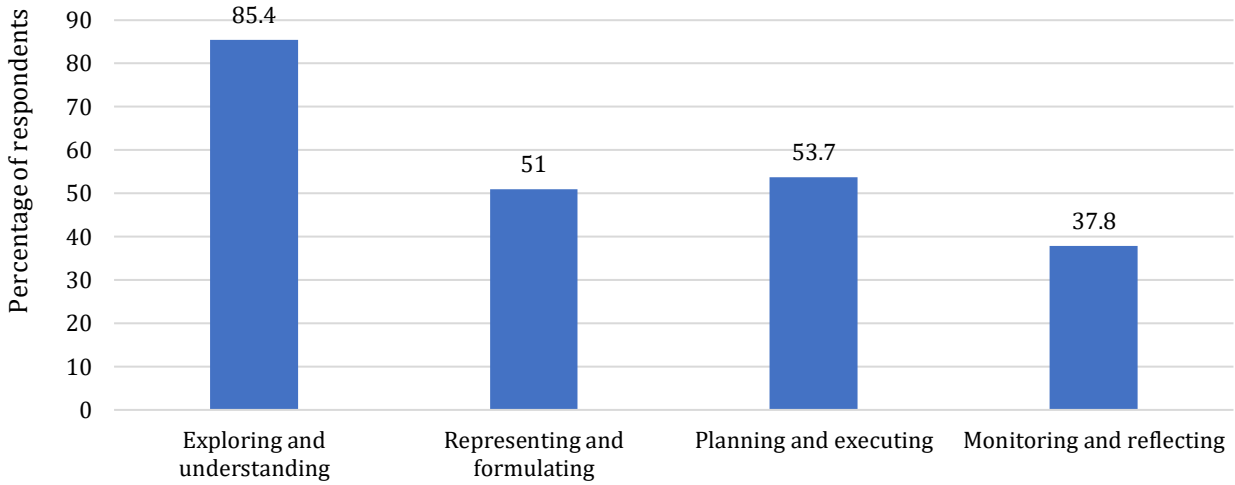

Figure 3. Percentage of implementation of the stages of problem-solving activities

Based on Figure 3, it was known that the implementation of the highest problem-solving activity stages was the Exploring and understanding stage (85.4%) while the lowest was the Monitoring and reflecting activity (37.8). This indicated that the stages of problem-solving activities were still not performed optimally by the respondents. Each stage has an important role in providing students with problem-solving skills so that all stages can be performed properly. Research activities can also be considered as problem-solving activities by thinking critically and making evidence-based decisions so that if the two activities are performed properly, integrated learning can be realized and mutually beneficial and strengthening relationships can occur (Willison, 2015).

Regarding new literacy, 68.3 % of respondents said that they knew about it and they applied it to equip research and problem-solving skills for students in lecturing activities. From the various respondents' answers, the answers were sorted including the application of Data Literacy (DL), Technological Literacy (TL), and Human Literacy (HL), and then recapitulated according to their grouping. Information about how problem-solving skills equipped in learning biodiversity as the efforts to realize learning of society 5.0 with research limitations on lecturers' efforts in implementing new literacy described in Table 1.

Table 1.
Problem-Solving Skills Equipped in Learning Biodiversity as The Efforts to Realize Learning of Society 5.0

Data Literacy (DL)	Technological Literacy (TL)	Human Literacy (HL)
• Accessing national and international journals online • Accessing online sites related to plant biodiversity data, identification, checking valid scientific names, • Optimizing the selection of characters used in the	• Mastering the use of software including Image Raster, SPSS to view the similarity index, • Introducing digital technology and software related to biodiversity to solve kinship problems, coding based on morphological character scores, introduction to DNA	• Practicing honesty in research. • Forming groups and assessments that are related to cooperation, ethics in team work, so that they become a solid team in solving plant biodiversity studies problems • Conducting a survey to the community about the use and processing of plants.

Data Literacy (DL)	Technological Literacy (TL)	Human Literacy (HL)
preparation of monographs with online data. • Utilizing information on research results or databases on the internet in accordance with student assignments or research projects • Reviewing and analyzing national and international journals • Creating an electronic portfolio to explain understanding of evolution • Assigning students to make articles sourced from scientific journals • Seeing the similarity index of the data entered with SPSS software to see the kinship relationship of a taxon • Analyzing the morphometry of organisms based on the application. • Using existing big data as a guide for generating exploration data, and as comparison data. • Using nucleotide sequence big data contained in the NCBI GenBank databese. • Using data from weather apps for student research • Using invasive species database • Identifing a species by accessing some online web (FishBase, Worms)	analysis software (clustal W, bioedit, BLAST etc.) • Using the library of GCMS data to identify a new compound from plant extracts • Teaching trace journals with Mendeley • Assigning students to make ppt of lecture materials and upload them to the web or the internet • Creating an electronic portfolio in the e-portfolio.id domain • Developing learning resources based on android applications • Performing phenetic analysis and marker characters as well as making dendograms and phylogenies with the application of technology • Utilizing the existing sequences in GebeBank to train students in the practice of designing primers for PV purposes • Involving students in genetic mapping research (DNA barcoding) to get superior seeds	• Creating an electronic portfolio and assess student creativity • Training students' creativity in writing the data obtained • Prioritizing humanity in ethics researching and developing creativity from the framework • Assigning students to prepare proposals for community service activities, according to local needs • Training about the ability to communicate observattions politely and respect others, reflect on the biodiversity of God's creation, be responsible for observing work in teams, discipline, critical and reflective of environmental conditions.

Based on the data in Table 1, the respondents had implemented new literacy activities. The new literacy consists of 1) data literacy: The ability to read, analyze, and use information (big data) in the digital world; 2) technological literacy: the ability to search for, read, identify, evaluate and use information in digital media as well as the ability to understand the workings of machines and technology applications (coding, artificial intelligence, engineering principles, and biotech); 3): and human literacy: The abilities that only humans have (robots do not have) include a sense of humanity, communication, making designs, creativity, intuition, emotionality, spirituality (Aoun, 2017). New literacy with the support of adequate facilities from university institutions, both human resources and technological facilities, will support the readiness of students to face the world of work (Dewi, Retno Sari, Amna, Rasmita, & Susanti, 2019; Lestari & Santoso, 2019).

Data literacy had been carried out by the respondents in Table 1 indicated that they had equipped their students to had the ability to read, analyze and use big data in lecture activities. Several studies on the application of new literacy including data literacy conducted by lecturers had received positive responses from students. The result in research about the development of integrated science to improve students' new literacy skills in cooperative learning gave information about student's stated that when they used integrated science teaching materials as a learning resource, they could construct new knowledge and literacy in science subjects (Rahmiwati et al., 2020). Through the study of chemical practicum, project-based instrument analysis associated with everyday life can increase new literacy skills which are the important point of the chemical students' competence (Prasetya, A. T., Cahyono, E., Haryani, S., 2020).Data literacy is currently important for scientists who research so that they can process data professionally, as well as students who use data from previous research findings to complement the results of research conducted so that the process of carrying out data literacy is more meaningful (Gebre, 2018; Kjelvik & Schultheis, 2019; Koltay, 2017).

Technological literacy was also equipped by the respondents to their students, especially the ability to use the information on digital media and current technological applications. The students and teachers can increase

their literacy ability using a model of **TECS** are to have the skills to apply **technology (T),** can analyze the changes in the various relationships involved in an **event/engaged relationships (E),** can analyze the flow of information with **complex power/complex power-informed pathway (C)** and long-term analysis ability for **shifts in professional identity (S)** (Hasse, 2017)**.** The result from research that explored the influence of self-regulated learning strategies on digital literacy in digital learning within blended learning environments indicated that self-regulated learning strategies had a big influence in fostering digital literacy. In these strategies, students must develop metacognitive processes, utilize resource management and motivational belief strategies to increase their digital literacy competency. Students with digitally literate will behave something better in performing digital tasks, have a learning experience, and thus lifelong learners (Anthonysamy et al., 2020)

One method to apply data literacy and technology literacy in learning is to use iNaturalist. iNaturalist is one of the world's most popular nature apps can helps students to identify the biodiversity of plants and animals around them. Students can connected with a community of many scientists and naturalists who can help learn more about nature. They also can contribute data from their research for scientists working to better understand and protect nature by recording and sharing their observations. The results of research related to iNaturalists are shown in Table 2 which indicates that there are still few respondents who are familiar with and use iNaturalists in learning.

Table 2.
Response results related to iNaturalist in learning

No	iNaturalist in learning	Persentase (%)
1	Lecturers who are familiar with the iNaturalist	32.9
2	Lecturers who are not familiar with the iNaturalist	67.1
3	Lecturers who use iNaturalist in lecture activities	20.7
4	Lecturers who did not use iNaturalist in lecture activities	79.3

The use of iNaturalis in learning activities has many benefits. Lecturers can use iNaturalist to equipped research and problem-solving skills for students, in the form of practicum activities that are integrated with iNaturalist for example identification of various biopesticide and medicinal plants, identification of coastal and swamp forest plants, and using naturalist references for research and learning. iNaturalist applications suggested as one of the technology applications that are suitable for research and problem-solving activities in biodiversity studies (Faizah et al., 2021). The iNaturalist application is one of the recommended applications in implementing new literacy, especially technological literacy to research biodiversity studies. This application is an 'online social network of people sharing biodiversity information to help each other learn about nature' thereby helping people to connect with nature through application technology. This application was developed with the primary objective of 'connecting people with nature, followed by the secondary objective of 'scientifically generating valuable biodiversity data from these community activities, which its founders believe can be achieved in conjunction with its main objective (Altrudi, 2021).

Human literacy had been seen in Table 2, the respondents equipped such as ability to work together in groups/cooperation, be honest, and be creative. Cooperation is part of the new literacy developed in the field of education so that students can achieve a balance between mastery of science and the use of technology by considering aspects of humanism so that they can build the character of superior students. Human literacy as an educational strategy can be done by integrating it into learning activities that interact with society and real-life (Sari, Rejekiningsih, & Muchtarom, 2020). The competency of the purpose of problem-solving activities are build and maintain mutual understanding between members of the team, take the appropriate action to resolve the problem as well as build and maintain teamwork within the organization can also be interpreted as one of the manifestations human literacy (OECD, 2017b). The competence trains team members to work together in solving a problem to interact and communicate with each other is the basic nature of humans as social beings that distinguishes them from robots (Aoun, 2017; Kaçan & Şahin, 2018).

Based on the previous explanations, the new literacy which consists of data literacy, technological literacy, and human literacy is very important to be equipped by lecturers to their students to face society 5.0. The lecturers had equipped problem-solving skills by integrating new literacy in various efforts in biodiversity learning in colleges as learning society 5.0. Currently, it seems that the implementation of the problem-solving stages has not been maximized, there are some stages that need to be improved. In addition, the lecturers need to increase the new literacy ability so they can equipped well their students. In the future, it is hoped that problem solving skills by integrating new literacy can become a necessity to be applied in more various universities.

CONCLUSION

This study concluded that various efforts had been made in biodiversity learning in colleges in equipping problem-solving skills as learning society 5.0. Lecturers need to increase skills of new literacy that support the implementation of learning of society 5.0. In the future, problem solving skills by integrating new literacy can become a necessity to be applied in more various universities.

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REFERENCES

Alkhatib, O. J. (2019). A Framework for Implementing Higher-Order Thinking Skills (Problem-Solving, Critical Thinking, Creative Thinking, and Decision-Making) in Engineering Humanities. *2019 Advances in Science and Engineering Technology International Conferences, ASET 2019*, 1–8. https://doi.org/10.1109/ICASET.2019.8714232

Altrudi, S. (2021). Connecting to nature through tech? The case of the iNaturalist app. *Convergence*, *27*(1), 124–141. https://doi.org/10.1177/1354856520933064

Amanda, F. F., Sumitro, S. B., & Lestari, S. R. (2021). Analysis of the Relationship Between Concept Mastery and Problem-Solving Skills of Pre-Service Biology Teachers in Human Physiology Courses. *Jurnal Pendidikan Sains Indonesia*, *9*(3), 421–432. https://doi.org/10.24815/jpsi.v9i3.19956

Anthonysamy, L., Koo, A. C., & Hew, S. H. (2020). Self-regulated learning strategies in higher education: Fostering digital literacy for sustainable lifelong learning. *Education and Information Technologies*, *25*(4), 2393–2414. https://doi.org/10.1007/s10639-020-10201-8

Aoun, J. E. (2017). *Robot-proof: higher education in the age of artificial intelligence*. Cambridge: MIT press.

Creswell, J. W. (2015). Educational Research - Planning, COnducting, And Evaluating Quantitative and Qualitative Research - Fifth Edition. In *AORN Journal* (Vol. 62).

Dewi, M., Retno Sari, Y., Amna, S., Rasmita, & Susanti, R. (2019). The understanding of lecturers about the new literacy in industrial revolution era 4.0: A study case of university of putra indonesia yptk padang. *Journal of Physics: Conference Series*, *1339*(1), 0–7. https://doi.org/10.1088/1742-6596/1339/1/012105

Faizah, U., Nuryani, Y., Ambarwati, R., & Rahayu, D. (2021). Persepsi Calon Guru Biologi tentang Keterampilan Memecahkan Masalah Biodiversitas: Kajian Terkait Society 5.0. *Urnal Inovasi Pembelajaran Biologi*, *2*(2), 12–23.

Fukuda, K. (2020). Science, technology and innovation ecosystem transformation toward society 5.0. *International Journal of Production Economics*, *220*(April), 107460. https://doi.org/10.1016/j.ijpe.2019.07.033

Fukuyama. Mayumi. (2018). Society 5.0: Aiming for a New Human-centered Society. *Japan SPOTLIGHT*, (August), 8–13.

Gebre, E. H. (2018). Young Adults' Understanding and Use of Data: Insights for Fostering Secondary School Students' Data Literacy. *Canadian Journal of Science, Mathematics and Technology Education*, *18*(4), 330–341. https://doi.org/10.1007/s42330-018-0034-z

Häkkinen, P., Järvelä, S., Mäkitalo-Siegl, K., Ahonen, A., Näykki, P., & Valtonen, T. (2017). Preparing teacher-students for twenty-first-century learning practices (PREP 21): a framework for enhancing collaborative problem-solving and strategic learning skills. *Teachers and Teaching: Theory and Practice*, *23*(1), 25–41. https://doi.org/10.1080/13540602.2016.1203772

Hasse, C. (2017). Technological literacy for teachers. *Oxford Review of Education*, *43*(3), 365–378. https://doi.org/10.1080/03054985.2017.1305057

Kaçan, S., & Şahin, F. (2018). Analysis of Science Teacher Candidates' Relation between Scientific Creative Thinking Skills, Creative Problem Solving and Project Development Skills. *SHS Web of Conferences*, *48*, 01059. https://doi.org/10.1051/shsconf/20184801059

Kjelvik, M. K., & Schultheis, E. H. (2019). Getting messy with authentic data: Exploring the potential of using data from scientific research to support student data literacy. *CBE Life Sciences Education*, *18*(2), 1–8. https://doi.org/10.1187/cbe.18-02-0023

Koltay, T. (2017). Data literacy for researchers and data librarians. *Journal of Librarianship and Information Science*, *49*(1), 3–14. https://doi.org/10.1177/0961000615616450

Lestari, S., & Santoso, A. (2019). The Roles of Digital Literacy, Technology Literacy, and Human Literacy to Encourage Work Readiness of Accounting Education Students in the Fourth Industrial Revolution Era. *KnE Social Sciences*, *3*(11), 513. https://doi.org/10.18502/kss.v3i11.4031

OECD. (2017a). PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic, Financial Literacy and Collaborative Problem Solving, revised edition. In *OECD Publishing*.

OECD. (2017b). PISA for Development Assessment and Analytical Framework. *OECD Publishing*. Retrieved from https://www.oecd-ilibrary.org/education/pisa-for-development-assessment-and-analytical-framework_9789264305274-en

Prasetya, A. T., Cahyono, E., Haryani, S., S. (2020). Chemical Practicum Learning Project-Based Instrument Analysis to Develop Students' New Literacy Skills. *The 6th International Conference on Science, Education and Technology (ISET 2020)*, *574*(Iset 2020), 726–732.

Rahmiwati, S., Festiyed, & Ratnawulan. (2020). The Development of Integrated Science to Improve Students' New Literacy Skills in Cooperative Learning. *Proceedings of the 2nd International Conference Innovation in Education (ICoIE 2020)*, *504*(ICoIE), 400–403. https://doi.org/10.2991/assehr.k.201209.257

Salgues, B. (2018). *Society 5.0: industry of the future, technologies, methods and tools*. John Wiley & Sons.

Sari, D. I., Rejekiningsih, T., & Muchtarom, M. (2020). The Concept of Human Literacy as Civics Education Strategy to Reinforce Students' Character in the Era of Disruption. *Advances in Social Science, Education and Humanities Research*, *397*(Icliqe 2019), 1132–1141. https://doi.org/10.2991/assehr.k.200129.140

Shiroishi, Y., Uchiyama, K., & Suzuki, N. (2018). Society 5.0: For Human Security and Well-Being. *Computer*, *51*(7), 91–95. https://doi.org/10.1109/MC.2018.3011041

Silitonga, H. T. M., Panjaitan, M., & Supriyati, Y. (2020). Problem solving based physics learning strategy to enhance students' higher order thinking skills. *Journal of Physics: Conference Series*, *1567*(4), 0–4. https://doi.org/10.1088/1742-6596/1567/4/042104

Willison, J. (2015). Researching, problem solving, critical thinking … same ship, different bay. *Proceedings of the Annual Conference of the Society for Research into Higher Education (SRHE), Newport, Wales*, (0193).

Yli-Panula, E., Jeronen, E., Lemmetty, P., & Pauna, A. (2018). Teaching methods in biology promoting biodiversity education. *Sustainability (Switzerland)*, *10*(10), 1–18. https://doi.org/10.3390/su10103812

Zaharin, N. L., Sharif, S., & Mariappan, M. (2018). Computational Thinking: A Strategy for Developing Problem Solving Skills and Higher Order Thinking Skills (HOTS). *International Journal of Academic Research in Business and Social Sciences*, *8*(10), 1265–1278. https://doi.org/10.6007/ijarbss/v8-i10/5297

Appendix 1.

Questionnaire of Problem-Solving Skill in Biology Lecture Activities

A. Identity of Respondents

If you are willing to be a respondent in this study, please continue to fill in the respondent's identity and answer the available questions.

1. You are willing to be a respondent in this study and will answer the questions given honestly. *
   - Yes
   - No
2. Name _____*
3. Origin University/College _____*
4. Mr./Ms./Brothers teach at *
   - Biology education study program
   - Biology study program
   - Science education study program
   - Science study program
   - Other…
5. HP No_____*
6. You are willing to be contacted if the researcher requires additional information*
   - Yes
   - No

B. Study of Biodiversity in Lectures

Biodiversity studies in the lectures referred to in this research are studies on subject matter that discuss various matters related to biodiversity/diversity of living things, including the level of diversity in living things (genes, species, ecosystems), similarities and differences between living things, the relationship between living things and their environment, distribution patterns of living things, evolutionary processes that occur in living things, utilization of living things by humans, threats faced by living things, as well as conservation efforts undertaken to preserve living things.

1. Mr./Mrs./Brothers teach courses with materials related to biodiversity studies*
   - Yes
   - No
2. Courses with materials related to biodiversity studies that you are capable of, among others*
   - Biodiversity/Introduction to Biodiversity
   - Evolution
   - Animal Systematics/Invertebrate Taxonomy/Vertebrate Taxonomy
   - Plant Systematics / Taxonomy of Low Plants / Taxonomy of Higher Plants
   - Protozoology
   - malacology
   - Entomology
   - ornithology
   - mycology
   - Zoogeography
   - Phytogeography
   - Other…

C. Problem Solving Skills in Lectures

The problem-solving skills in this study refer to the OECD (2017) framework.

1. Do you provide students with problem-solving skills in lecture activities? *
   - Yes
   - No
2. If you provide problem-solving skills in lecture activities, which of the following things do you provide to students?
   - Explore and understand the problem-solving activities carried out (Exploring and understanding)
   - Representing and formulating problem solving activities to be carried out (Representing and formulating)
   - Plan and carry out problem-solving activities (Planning and executing)
   - Monitor and reflect on the problem-solving activities carried out (Monitoring and reflecting)
3. What are the forms of problem-solving skills training activities that you do in lecture activities? *
   - Weekly practicum activities according to lecture material
   - Project assignment activities (self-research) as a final semester project
   - Other…
6. What is the form of implementation guidance to solve problems that you do in lecture activities?*
   - Students are fully guided by lecturers at every step of research and problem solving.
   - Students independently determine the steps of research and solve problems carried out, lecturers provide sufficient guidance according to student needs.
   - Students independently determine the steps of research and solve problems carried out, without the guidance of lecturers.
   - Other…
7. Do you have difficulty in providing solving skills for students? *
   - Yes
   - No
   - Other…
8. If your answer is yes, what difficulties did you experience?
   - The limited competence of lecturers in carrying out the provision of research and problem-solving skills for students.
   - The limited time for lecturers in carrying out the provision of research and problem-solving skills for students.
   - Limitations of programs that are suitable for use in lectures to carry out debriefing of research and problem-solving skills for students.
   - Limited competence of students in carrying out research and problem-solving skills
   - Limited student motivation in carrying out research and problem-solving skills
   - Other…
9. If your answer is no, what supporting things did you experience?
   - The existence of appropriate competence of lecturers in carrying out the provision of research and problem-solving skills for students.
   - There is a lecturer's time available in carrying out the provision of research and problem-solving skills for students.
   - The existence of appropriate programs used in lectures to carry out debriefing of research and problem-solving skills for students.
   - The existence of appropriate student competencies in carrying out research and problem-solving skills
   - There is student motivation in carrying out research and problem-solving skills
   - Other…

D. New Literacy

The new literacy in this study is based on Aoun (2017) which consists of: 1) data literacy/data literacy: The ability to read, analyze, and use information (big data) in the digital world; 2) technological literacy: The ability to search, read, identify, evaluate and use information available on digital media as well as the ability to understand the workings of machines and technology applications (coding, artificial intelligence, engineering principles and biotech); 3) human literacy: Capabilities that only humans have (robots do not have) include a sense of humanity, communication, design, creativity, intuition, emotionality, spirituality.

1. Did you know about new literacy before? *
   - Yes
   - No
2. Have you implemented new literacy skills in carrying out lecture activities to provide students with problem-solving skills? *
   - Yes
   - No
   - Other…
3. If you have implemented new literacy, especially data literacy to provide problem-solving skills for students,

please state/explain the form of application

_____

4. If you have implemented new literacy, especially technological literacy to provide problem-solving skills for students, please state/explain the form of application

_____

5. If you have implemented new literacy, especially human literacy to provide problem-solving skills for students, please state/explain the form of application

_____

6. If you have not implemented it, will you apply new literacy in lectures to provide problem solving skills for students?
   - Yes
   - No
   - Maybe

E. iNaturalist App

The iNaturalist application is an application that can be used via a PC/computer/laptop or smartphone that allows users to share information about species in nature. Users can upload photos of animals or plants they find to the app and other users who know about the species can provide information/help identify them.

1. Did you know about the iNaturalist application before?
   - Yes
   - No
2. Have you ever used the iNaturalist application to provide research and problem-solving skills for students? *
   - Yes
   - No
   - Other…
3. If you have used iNaturalist to provide research and problem-solving skills for students, please state/explain the form of the activity.

_____

4. In your opinion, is it necessary to develop a program that can provide problem-solving skills for biology students in general and prospective biology teacher students in particular? *
   - Yes
   - No
   - Other…