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The Needs Analysis for the Development of an Ethnoecological-STEAM Project-Based Learning Model with the Utilization of Water Hyacinth to Improve 21st Century 4C Skills for Students as Science Teacher Candidates

M. Hidayatur Rohman*, Putut Marwoto, Sunyoto Eko Nugroho, Supriyadi

Universitas Negeri Semarang, Indonesia

*) Corresponding Author: hidayat80@students.unnes.ac.id

Abstract. Students need to master 21st-century skills from primary education to higher education, the aim is to respond to the paradigms and characteristics of 21st-century education. One of the activities to answer the challenges of 21st-century education is the development of learning models. This study aims to analyze the need to develop learning models to improve 21st-century skills for prospective science teacher students. The research method used is an Exploratory Sequential Mixed Methods Design with three stages, while the general procedure for developing learning models uses the ADDIE method (Analyze, Design, Develop, Implement, and Evaluate). The needs analysis in this research is part of the qualitative exploration stage related to the first stage of data collection, and the second stage is about the draft model development, or in the ADDIE method, it is included in the analysis and design stage. The research subjects were 10 science lecturers, 33 science education students, and 37 science teachers at junior high schools in the Semarang district. The innovative model developed is an Ethnoecological-STEAM project-based learning model (PjBL E-STEAM) with the utilization of water hyacinth to improve 21st-century 4C skills for students as science teachers' candidates. The results of the needs analysis are the initial product of the model development that will be piloted, namely the syntax of the PjBL E-STEAM model (Learn, Discuss, Perform, Elaborate, Convey, Practice, Evaluate, and Use), the PjBL E-STEAM based Learning Module, and instruments to measure 21st-century 4C skills.

Keywords: Project-based Learning (PjBL); STEAM; 21st Century Skills; Ethnoecology; Water Hyacinth

INTRODUCTION

21st-century skills are important skills that must be mastered by every student, from basic education to higher education in facing challenges, problems, life, and careers in the 21st century (Redhana, 2019). Therefore, it is necessary to prepare human resources who master various skills to survive in the 21st century. Preparation of human resources will be effective if pursued through education (Redhana, 2019). 21st-century skills as student learning outcomes are divided into 3 (three) categories, namely learning and innovation skills or 21st-century skills 4C (Critical thinking, Communication, Collaboration, and Creativity) (Santi, et al. 2020), information and communication technology literacy skills, as well as life and career skills (Van Laar, et al., 2017; Prayogi and Aesthetics, 2019). Achievement of these 21st-century skills can be done by updating the quality of learning, helping students develop participation, adjusting personalized learning, emphasizing project-based learning, encouraging collaboration and communication, increasing student involvement and motivation, cultivating creativity and innovation in learning, using learning tools appropriate, as well as designing learning activities that are relevant to the real world (Jayadi et al., 2020). In the interests of national education goals and responding to the challenges of the 21st century, the Indonesian government has also established the 2013 curriculum which was developed to meet the three categories of 21st-century skills above, and by adding moral character, namely love for the motherland, noble character values, honest, fair, compassionate, respectful,

In higher education, especially the Education Personnel Education Institute (EPEI) as an institution that plays a role in improving teacher competence, the Government of Indonesia also issued Menristekdikti Regulation Number 44 of 2015 concerning Higher Education Standards that EPEI is a follow-up in response to the characteristics of 21st-century education. The Permenristekdikti says that EPEIs must aim for teachers to have a strategic role in educating the nation's life, advancing science and technology by applying humanities values, as well as cultivating and empowering the Indonesian people sustainably. EPEI graduates must have

abilities that include attitudes, knowledge, and skills. For example, Undergraduate graduates must at least master theoretical concepts in certain areas of knowledge and skills in general and theoretical concepts specifically in the areas of knowledge and skills they study in depth. This knowledge and skills must be reflected in the competence of graduates or the learning achievements of each study program and must refer to the formulation of descriptions in the Indonesian National Qualifications Framework (INQF) according to their level (Menristekdikti, 2015). Presidential Regulation Number 8 of 2012 states that undergraduate students must be able to apply their areas of expertise and utilize science, technology, and/or art in their fields of problem-solving, and be able to adapt to the situation at hand.

Facts on the ground found that the learning conditions in tertiary institutions for EPEIs in general still found several major problems. This is to the findings by the Higher Education Curriculum Development Team, Directorate of Higher Education, among which there are still several lecturers who lack understanding or do not care about learning outcomes, learning strategies, and methods, as well as appropriate assessment methods (Suyatna, 2014). Lecturers do not understand the curriculum so the implementation of the curriculum becomes narrow and rigid. The development of learning materials contextually is still very limited. Lecturers don't prepare learning tools before learning, lectures are dominated by monotonous lectures and/or discussions. Lecturers do not formulate learning outcomes and lectures are only limited to fulfilling the number of face-to-face meetings (Sutrisno & Suyadi, 2016). Therefore, there is a need for improvement and creativity in learning methods and models. The model developed is of course a learning model that can answer both of these, namely the characteristics of 21st-century education and educational standards set by the government, namely those that have interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and centered characteristics. on students. Therefore, it is necessary to do a needs analysis in the process of developing the learning model, so that the learning objectives using the model to be developed can be achieved. there needs to be improvement and creativity in learning methods and models. The model developed is of course a learning model that can answer both of these, namely the characteristics of 21st-century education and educational standards set by the government, namely those that have interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and centered characteristics. on students. Therefore, it is necessary to do a needs analysis in the process of developing the learning model, so that the learning objectives using the model to be developed can be achieved. there needs to be improvement and creativity in learning methods and models. The model developed is of course a learning model that can answer both of these, namely the characteristics of 21st-century education and educational standards set by the government, namely those that have interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and centered characteristics. on students. Therefore, it is necessary to do a needs analysis in the process of developing the learning model, so that the learning objectives using the model to be developed can be achieved. namely, those that have interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and student-centered characteristics. Therefore, it is necessary to do a needs analysis in the process of developing the learning model, so that the learning objectives using the model to be developed can be achieved. namely, those that have interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and student-centered characteristics. Therefore, it is necessary to do a needs analysis in the process of developing the learning model, so that the learning objectives using the model to be developed can be achieved.

21st-century education is education in an era of openness or globalization which is characterized by advances in science and technology, especially digital technology (Van Laar, et al., 2017; Rahayu, 2017; Jayadi et al., 2020) so that models and methods are needed learning to answer. The aim of education is not only to prepare students to pass examinations, but also to nurture students to learn in a way that is transferable to their future in personal, cultural, professional, academic, and civic life (Tierney, et al. 2022). 21st-century education applies a lot of student-centered learning models, including project-based learning (PjBL) models (Redhana, 2019). The PjBL model is a teaching approach that is built on learning activities and real assignments in a "constructivist" learning environment that is created in groups with students building their knowledge and educators

becoming facilitators (Goodman, et al., 2010). The PjBL approach can be viewed as an approach to creating a learning environment that can encourage students to construct knowledge and skills personally (Hadinugrahaningsih, et al., 2017)

Project-based learning has a significant contribution to improving student learning outcomes and 21st-century skills. Khoiri, et al. (2016) used the PjBL learning model to see students' abilities, creativity, and learning outcomes. The result is that the PjBL learning model is effective in student learning outcomes. There is an increase in science learning outcomes for students who use the PjBL model on Environmental Pollution material (Sitompul, et al., 2020). Integrated science learning with the PjBL model with the theme of water pollution can improve students' mastery of concepts (Yamin, et al., 2017). The project-based learning model is better than conventional learning (Afriana, et al., 2016). The PjBL model can cultivate high-order ways of thinking in implementing scientific learning (observing, associating, trying, discussing, and communicating) as well as 21st-century learning 4C (Santi, et al., 2020). The application of the PjBL model makes a good contribution to improving students' scientific literacy and critical thinking abilities (Muhibbuddin, et al., 2020). PjBL improves important skills, such as collaboration, communication, creativity, and critical thinking (Allison, 2018; Samsudi, et al., 2019), as well as communication, responsibility, problem-solving, and information processing (Sudjimat, 2021).

An approach in the learning process that keeps up with the times, apart from PjBL is to integrate Science, Technology, Engineering, and Mathematics (STEM) (Lestari, et al., 2018). STEM education is a pedagogical philosophy that aims to draw links between science, technology, engineering, and mathematics to solve complex problems in real-life situations (Changtong, 2020) or that study academic concepts related to the real world (Lestari, et al., 2018). STEM is an important interdisciplinary learning approach for students in the 21st century that is used for problem-solving, technology, innovation, and communication with various media tools (Oner, et al., 2016). In the development of the world of education today, to be successful in STEM learning, not only STEM knowledge and skills but creativity is also required. Creative people report the discovery process as the most pleasurable experience, bridging creativity and science as closely related fields (Conradty & Bogner, 2018). The STEM curriculum can benefit from the integration of the arts to encourage creative solutions (Henriksen, 2014). The integration of art is expected to be able to make learning more meaningful because students are involved in realizing learning competencies that must be achieved in real terms (Hadinugrahaningsih, et al., 2017). Integration of the arts with STEM subjects to increase student engagement, creativity, innovation, problem-solving skills, and other cognitive benefits (Root-Bernstein, 2015). Therefore, art is then integrated into STEM disciplines and then designated as STEAM education (Oner, et al., 2016) so that the term STEAM is an integration between Science, Technology, Engineering, Art, and Mathematics. STEAM is an integrated learning approach (integrative thematic) that is designed to involve many standards, models, assessments, and designs/implementations across fields/subjects, learning between two or more STEAM components or between one STEAM component and other disciplines. At the heart of the STEAM approach is a model of inquiry, collaboration, and an emphasis on process-based learning. Learning with the STEAM approach is contextual learning that invites students to understand the phenomena around them (Yakman & Lee, 2012).

Based on the background of the problems above, this research will analyze the need for the development of learning models that integrate PjBL-STEAM, and local wisdom as one of the phenomena in everyday life. The local wisdom in question is the Ethnoecology of the use of water hyacinth plants in the community around Lake Rawa Pening which is located in Semarang Regency, Indonesia. The aim of integrating the Ethnoecology project on the use of water hyacinth, in addition to enhancing 21st century 4C skills, is also to increase students' environmental care character. Furthermore, the model innovation that will be developed and needs analyzed is the Ethnoecological-STEAM project-based learning model with the use of water hyacinth (PjBL-ESPEG) to improve 21st-century 4C skills for students as science teacher candidates.

METHODS

The research method used is method *Exploratory Sequential Mixed Methods Design* with three steps (Creswell, 2018; Leavey, 2017). The first stage is a qualitative exploration

in the form of collecting and analyzing qualitative data on the findings in the Ethnoecology field of the use of water hyacinth which can be integrated as a project in the science course, namely Environmental Physics. Exploration was also carried out regarding the PjBL-based learning model approach which was integrated with STEAM obtained from lecturers and students, as well as junior high school science teachers in Semarang Regency. The second stage is a qualitative exploration by identifying features for testing in the form of research instruments, model books, and learning modules, as well as the variables needed in the development of learning model drafts. The third stage is quantitative testing of the draft learning model in trials both on a small and large scale. The needs analysis in this study is part of the qualitative exploration stage related to the first and second stages, or in the ADDIE method, it is included in the first and second stages *analyze* and design. The research subjects were 10 science lecturers, 33 science education students, and37 science teachers at junior high schools in the Semarang district

Stage *analyze* in the form of an analysis of the needs of various information related to the development of learning models that will be carried out, consisting of two activities, namely library research and field studies. The activities carried out in this literature study were to examine the analysis of CPL, CPMK, and Sub CPMK. Analysis of students needs to be related to Environmental Physics material which is integrated into the Ethnoecology material for the use of water hyacinth. The next step is to review references in the form of books and research journals on relevant learning models, namely studies on the PjBL model that is integrated with STEAM and the Ethno-STEM model. A study was also conducted on variables related to 21st-century 4C skills, information technology literacy skills, and environmental care character. Field study activities were filled with observing and interviewing about perceptions and habituation of using the PjBL-STEAM model in science courses for science lecturers and Tadris/science education students. Observation sheets in the form of questionnaires were given to lecturers or students and interview sheets about habituation were given to lecturers supporting natural science courses. The results are used for the preparation of the initial product of the PjBL-ESPEG model in the Environmental Physics course. Observations through interview sheets were also made for science teachers who are members of the Science Teacher MGMP throughout Semarang Regency. The results of the interviews are used to consider the selection of the PjBL-ESPEG model in Environmental Physics lectures.

The design stages the preparation of the initial product of the PjBL E-STEAM Model, including the preparation of learning device drafts in the form of semester learning plans (RPS) and learning modules, preparation of research instruments, validation sheets, and preparation of questionnaires. The results of the initial product preparation were then requested for input from science experts and lecturers through group discussion forums (FGD). Suggestions and input from FGD participants were then used for product revisions before being brought to expert validators. The stages and procedures up to the analyze and design stage in this study can be seen in Figure 1.

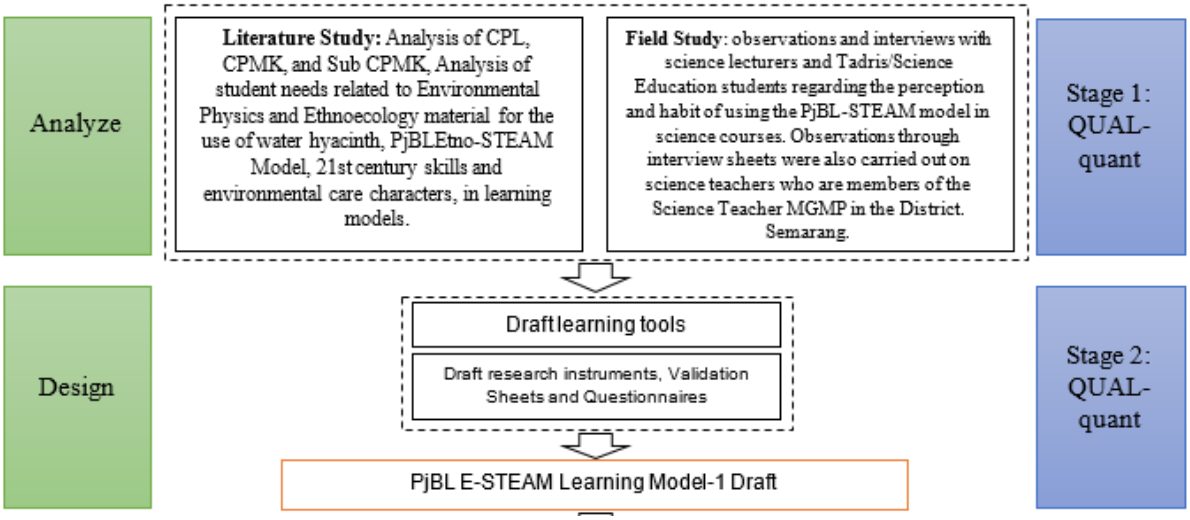

Figure 1. PjBL E-STEAM Model Development Needs Analysis Research Procedure

RESULTS AND DISCUSSION

The results of the study present a needs analysis (Analyze) and development (Design) related to the development of learning modelsPjBL E-STEAM. The analysis starts with a literature study on the PjBL-STEAM model and field studies on the habituation and perceptions of applying the PjBL-STEAM model in lectures. Furthermore, for the hypothetical model, an analysis of the literature related to the syntax of the developed model was carried out. Curriculum analysis is carried out to determine the subject matter that is by the model and modules that will be used by the media in developing the model.

The results of a literature study on the PjBL-STEAM model show that the PjBL model can cultivate high-order thinking (HOT) in implementing scientific learning (observing, associating, trying, discussing, and communicating) as well as 21st-century learning (4C: Critical thinking, Collaboration, Creative, Communication). The PjBL model can also be used to improve 21st century 4C skills by integrating with the STEAM approach (Santi, et al. 2020). To answer this, the results of observations of science lecturers and students of science education at UIN Salatiga will be described. The science lecturer will reveal his perceptions and usage habits of the STEAM-integrated PJBL model, and students will answer the impact or advantages of using STEAM-integrated PjBL in science lectures. The previous observation sheet was validated by several experts whose results were analyzed using the content validity coefficient –Aiken's V (CVI) and construct validity using Pearson's correlation in the SPSS version 21 application with a significant level of 0.05, while the reliability test showed that all items were reliable with a value*Cronbach's Alpha.*

The results of content validity for the science lecturer's perception observation sheet with CVI = 0.93 or very valid and Cronbach's Alpha = 0.864 or reliable. Overall, the 10 lecturers gave a very good response with a score of 87.75%. This means that the PjBL model that is integrated with STEAM is very well applied in the learning or lecture process to improve 21st-century skills. The results of the observation sheet analysis on the habituation of the PjBL-STEAM model in lectures with CVI = 0.92 or very valid, construct validity using Pearson's correlation on SPSS application version 21 with a significant level of 0.05, while the reliability test showed that all items were reliable with a Cronbach's *Alpha* =0.843. The results of the analysis show that in lectures that use STEAM-integrated PjBL, lecturers still have difficulty incorporating elements of art into learning and the use of technology and machines. However, overall the 8 respondents stated that the habit of using STEAM-integrated PjBL in science lectures was very good, namely giving a response of 89.21%. This means that every science lecturer must start getting used to implementing the use of STEAM-integrated PjBL to improve the skills of 21st-century students (Santi, et al., 2021).

The results of observations of these lecturers were complemented by student perceptions which revealed the advantages of using the STEAM-integrated PJBL model in science lectures. Observations were made of 33 students of Tadris Science/Science Education at IAIN Salatiga. The data collected aspects have been adapted to the PjBL model steps where each of these steps has been integrated with STEAM elements. The statements in the previous questionnaire have been validated by several experts. The results of CVI analysis = 0.92 or very valid. The construct validity uses Pearson correlation in the SPSS version 21 application with a significant level of 0.05, while the reliability test shows that all items are reliable with a value*Cronbach's Alpha* =0.765. They agreed to give a good perception of the use of the STEAM-integrated PjBL model, namely by giving a response of 81.52%. From student perceptions, it can be written down some of the advantages of using the STEAM-integrated PjBL model. First, STEAM-integrated PjBL can train students to think critically and connect science with technology. Second, the STEAM-integrated PjBL model can train students to collaborate, communicate and be independent. Third, developing investigative abilities by utilizing equipment/machinery and technology, and students utilizing IT media to find sources of information. Fourth, train students to think at a high level, critically, and creatively. Fifth, utilizing technology and machines as well as designing calculation products that are accurate and have artistic value.

Based on the analysis of the results and discussion of the perceptions and habits of science lecturers using the STEAM-integrated PjBL model in science courses, it is known that they strongly agree to use this model in science

lectures. Lecturers have a very good perception or assessment of the STEAM-integrated PjBL model and continuously use this model to improve students' critical thinking skills and 21st-century skills. However, they still have difficulty incorporating elements of art into learning, and there are constraints by the limitations of technology and machine facilities. This can be overcome by continuously familiarizing the model in science courses that are compatible with the STEAM-integrated PjBL model.

The PjBL-STEAM model can also be applied to courses with environmental concepts, as is the case with research conducted by Rahmayanti, et al., (2020), that environmental concepts can also be taught using the STEAM approach because environmental science is a transdisciplinary science and is integrated with various another concept. Wahyuni (2015) states that there is a need for integration between the environment and local wisdom in every science learning material. Integration of local wisdom in science learning is an innovation that provides the widest possible opportunity for students to achieve learning goals as a provision for facing future life while still being guided by their regional cultural values (Utami and Dewi, 2017).

The integration of project-based learning models with STEM which studies local wisdom (ethnoscience), by Sudarmin, et al (2019) and Sumarni & Kadarwati (2020) is called the Ethno-STEM project-based learning model. The Ethno-STEM approach can be interpreted as a process of building scientific concepts through local wisdom and integrated with STEM (Sartika, 2022). Sumarni & Kadarwati (2020) stated that the Ethno-STEM project-based learning model can improve critical thinking skills and creative thinking. Another ethnoscience discipline that can be integrated into science learning is Ethnoecology. The definition of ethnoecology is explained by Himanto (2010), which is a science that bridges natural sciences, social sciences, natural environmental sciences, and social environmental science which focuses on humans as actors in natural environment activities. Ethnoecology is a science that discusses the close relationship between humans, living space, and all human activities on Earth. The main ideas of Ethnoecology are the environment and humans, which are the bridge between natural science and social science. Ethnoecology is the science of local community ecology and its relationship to the environment in which they live (Halbert & Rui, 2015). An example of an Ethnoecological study of community activities, namely community activities around rivers, lakes, or swamps in utilizing water hyacinth plants. and all human activities on earth. The main ideas of Ethnoecology are the environment and humans, which are the bridge between natural science and social science. Ethnoecology is the science of local community ecology and its relationship to the environment in which they live (Halbert & Rui, 2015). An example of an Ethnoecological study of community activities, namely community activities around rivers, lakes, or swamps in utilizing water hyacinth plants. and all human activities on earth. The main ideas of Ethnoecology are the environment and humans, which are the bridge between natural science and social science. Ethnoecology is the science of local community ecology and its relationship to the environment in which they live (Halbert & Rui, 2015). An example of an Ethnoecological study of community activities, namely community activities around rivers, lakes, or swamps in utilizing water hyacinth plants.

The utilization of water hyacinth plants is human activity as a result of the environmental conditions where they live, in this case, the people around the lake/swamp use water hyacinth because of its abundance, and has the potential to become a weed if not used or harvested. The utilization of water hyacinth can produce types of crafts that have economic value, are good, feasible, and can meet the needs of life (Hidayatullah, 2011). Water hyacinth can be used as a raw material for making multiplexes, bags, paper, compost, biogas, furniture, and various handicraft products (Akbar, 2020). Water hyacinth is an organic material that can be used to produce biogas as renewable energy (Astuti, 2013). Utilization of water hyacinth plants can also be used to reduce cod content (chemical oxygen demand), ph, odor, and color in waste (Ratnani, 2011), phytoremediation (Djo, 2017), as compost (Ismail, et al., 2020), fish feed (Putra, et al., 2020; Kurniawan, et al., 2022) and for biogas (Redindingli, 2015) or biomass (Feng, et al., 2017). Water hyacinth can also be used in the field of acoustics in terms of reducing noise, namely as an acoustic material or sound-absorbing material (Febrita & Elvaswer, 2015; Rohman, et al., 2022). Water hyacinth can be used as an alternative fuel for water hyacinth briquettes (Dwiyati & Kholil, 2014; Balong, et al., 2016), and in physics learning it can be used as an alternative material for diffraction gratings (Marwoto, et al., 2022).

Based on the analysis above, the innovative learning model that will be developed in this study is the integration model between PjBL, STEAM, and Ethnoecology. The name of the model uses terms such as research conducted by Sudarmin, et al (2019) and Sumarni & Kadarwati (2020), namely the Ethno-STEM project-based learning model (PjBL Ethno-STEM). This model was then implemented in Environmental Physics courses with the integration of Ethnoecology science in the form of water hyacinth utilization projects, as well as adding elements of art (art) in STEM terms so that the name became the PjBL Ethnoecological-STEAM model. The selection of the PjBL Ethnoecological-STEAM (PjBL E-STEAM) model that utilizes natural water hyacinth plant materials is also based on facts in the field, namely the results of observations and interviews with 37 (thirty-seven) science teachers in junior high schools (SMP) in Semarang Regency. The results of the interviews obtained data that there was still little use of the project-based learning model (PjBL) as the main choice in the learning process, namely only 5 teachers (13.5%), while 16 teachers (43.2%) used the discovery learning model (discovery learning). and another 16 teachers (43.2%) used the problem-based learning (PBL) model. The application of STEAM integration in science learning which is a combination of various disciplines is also still low, namely only 24.3% answered often, while most answered rarely as much as 54.1%, and some never applied as much as 21.6%. Regarding the use of natural materials in their learning, most of them have applied it as many as 8, 1% always, 75.7% often, 16.2% rarely, and no one has ever used it. However, most of the utilization of natural materials from water hyacinth plants has never been as much as 59.5%, while 29.7% rarely, and only 10.8% often use them.

The next analysis is a literature review related to the syntax that will be applied to the PjBL E-STEAM model. The syntax of this model is derived from the PjBL syntax according to The George Lucas Educational Foundation (2005) and the PjBL-STEAM learning syntax according to Laboy-Rush (2010). The development output learning syntax from Lucas and Laboy-Rush results in eight steps, as follows: Learn, Discuss, Perform, Elaborate, Convey, Practice, Evaluate, and Use, as in Table 1.

Table 1. PjBL E-STEAM Syntax Formulation

Stages	PjBL (Lucas)	PjBL-STEAM (Laboy-Rush)	SyntaxPjBL E-STEAM
First	*Start with the essential question*	Reflection (providing problems and inspiration to start investigations)	Learn (study the problems given and ask challenging questions)
Second	*Design a plan for the project*	*Research* (start research/find relevant sources of information)	Discuss (discussing project topic, design, and schedule)
Third	*Create a schedule*	*Discovery* (solving a problem through a project)	Perform (carry out the project according to the agreed design and schedule)
Fourth	*Monitor the students and the progress of the project*	*Application* (use the concept on the project and test the project)	Elaborate (Elaborating on the application of concepts to projects, bringing out creativity with communication and collaboration
Fifth	*Assess the outcome*	*Communications* (project presentation/feedback)	Convey (presenting the results of project implementation)
Sixth	*Evaluate the experience*		Practice (demonstrating or demonstrating project results in accordance with work procedures)
Seventh			Evaluate (evaluating the results and experience of implementing the project)
Eighth			Use (implementing the project in life)

The PjBL E-STEAM syntax is as shown in Table 1, then applied to Environmental Science learning. The next needs analysis is regarding the material or subject matter in science courses. Ethnoecology from the utilization of water hyacinth plants was then chosen to be integrated into Environmental Physics material. From the several studies above, the integration of the use of water hyacinth plants that are suitable for the Environmental Physics material is 1) Phytoremediation in the Water Environment chapter, 2) Compost fertilizer in the Waste utilization for the environment chapter, 3) Sound absorbing materials in Acoustic material and its problems, 4) Briquette fuel in the Energy Resources chapter, 5) Diffraction grating in the Solar Energy chapter and its uses in life, 6) Biogas in the Renewable Energy chapter, and 7) Fish feed ingredients in the Environmentally Sustainable Development chapter. The choice of integrating the use of water hyacinth plants in learning is due to the nature of the water hyacinth plant which is easy to grow and reproduce. Water hyacinth plants are easy to plant in campus or school ponds so they don't have to go directly to lakes or rivers. Integrating Ethnoecology in learning physics is an innovative effort to relate physics subject matter to the lives and environment of students.

CONCLUSION

The results of the analysis of the need for the development of learning models that can answer the challenges of the 21st century is the integration of project-based learning models (PjBL) and STEAM. This model is very suitable to be applied to science courses and environmental materials. The results of the analysis based on literature and field studies obtained the integration of PjBL-STEAM with Ethnoecology so that the model developed was PjBL E-STEAM. Ethnoecology that is integrated is the use of water hyacinth in the Environmental Physics course, while the integration of the material is as follows: 1) Phytoremediation in the Water Environment chapter, 2) Compost fertilizer in the chapter Utilization of waste for the environment, 3) Sound dampening materials in Acoustic material and its problems, 4) Briquette fuel in the chapter Energy resources, 5) Diffraction grating in the chapter Solar energy and its uses in life, 6) Biogas in the Renewable Energy chapter, and 7) Fish feed ingredients in the Environmentally Sustainable Development chapter. Furthermore, the material is used as material for preparing learning modules. The PjBL E-STEAM syntax used includes Learn, Discuss, Perform, Elaborate, Convey, Practice, Evaluate, and Use.

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