PBL-STEM Integrated Interactive E-Module in Improving Creative Thinking Skills and Collaboration Skills: Needs Analysis in Biology Education

1. Introduction

The era of Society 5.0 requires everyone to be able to have the ability to think critically and constructively [1–3], trying to better prepare their human resources as a filter for the challenges posed by Industry 4.0 which gave birth to various innovations and industrialization [4,5] [6,7]. In this case, the role of education is very important [6,7]. These skills

Abstract.

1. 1.1 Creative Thinking Skills

1. 1.2 Collaboration Skills

1. 1.3 Needs Analysis in Biology Education

1.1 Creative Thinking Skills

Creative thinking skills are skills that involve cognitive, analytical, rational, and logical processes and invite individuals to do reflective thinking about problems. The application of STEM integrated with problem-based learning (PBL) and packaged in E-modules will produce creative individuals through creative thinking skills and collaboration. This research design uses qualitative description. This study aims to determine the need of teaching materials in the form of PBL-STEM-based E-modules in improving the creative thinking skills and collaboration skills of Biology Teacher Candidates. The subjects of this study were 172 Biology Teacher Candidates and 39 Biology education lecturers. Data collection was done by distributing questionnaires. The results of data analysis showed that there were only 28.2% of lecturers and 23.5% of Biology Teacher Candidates using e-modules in biology learning. 100% of lecturers and 87.5% of Biology Teacher Candidates stated the need for PBL-STEM integrated interactive e-modules in Biology learning, and there were 94.9% of lecturers and 98.8% of Biology Teacher Candidates considered it necessary to master creative thinking skills and collaboration skills.
The four pillars each contain specific skills that need to be empowered in learning, including creative thinking skills and collaboration skills. These skills will give individuals confidence and courage in living their daily lives. Almost all skills can be learned or improved with patience and extra practice.

In science learning, it is necessary to apply creative thinking skills, because creative thinking is a person's ability to analyze new information and combine unique ideas or ideas to solve a problem. A problem can be solved precisely and quickly if collaboration is carried out, so it is necessary to develop collaboration skills in Biology Teacher Candidates. Collaboration skills are considered important in the learning process because these collaboration skills can improve academic performance and can improve social sense in students. Collaboration is one of the skills that must be possessed by today's students to be ready when entering the world of work, today's students are required to be able to collaborate in the campus environment as well as with the global community. In addition to being ready to enter the world of work, collaboration skills require students so that students get harmony in life, namely living together with others, respecting each other's opinions, can increase job prospects, and can foster commitment to community participation. Collaboration skills help develop the importance of the social and personal dimensions of a prospective biology teacher.

2 Method

The research method used is a descriptive quantitative research method through a survey technique. The samples of this study were 74 Biology Teacher Candidates and 18 lecturers of Biology Education study programs from various universities in Indonesia. The research instrument was a questionnaire consisting of 11 questions for Biology Teacher Candidates and 13 questions for lecturers. The research instrument was made by researchers with Google Forms and validated by expert lecturers in the Biology Education Study Program, at the University of Lampung. The research instrument is valid and feasible to use in collecting research data. The research data collection technique used a questionnaire given through a Google form distributed via WhatsApp. In Google Forms, research data has been analyzed automatically, and with the help of Ms. Excel. Furthermore, research data in the form of a percentage of responses from Biology Teacher Candidates and lecturers were analyzed descriptively.

3 Result and Discussion

Survey results of Biology Teacher Candidates' responses to the STEM-PBL integrated interactive e-module in improving creative thinking skills and collaboration skills are presented in Table 1.
Table 1. Results of data analysis of Biology Teacher Candidates' response to STEM-PBL integrated interactive e-modules

<table>
<thead>
<tr>
<th>No</th>
<th>Question Item</th>
<th>Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What teaching materials do your lecturers use in giving lectures? (may choose more than one)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Textbooks: 23.78</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning Modules: 57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biology Teacher Candidate: 36.9</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Have you ever seen a Biology E-module used by your lecturer?</td>
<td>37.8</td>
</tr>
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<td>3</td>
<td>In giving lectures, has your lecturer introduced STEM learning?</td>
<td>35.6</td>
</tr>
<tr>
<td>4</td>
<td>If you have used the STEM approach, on what material/subject?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microbiology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biotechnology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ecology</td>
<td></td>
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<tr>
<td></td>
<td>Curriculum Review</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physiology</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>In your opinion, do you think collaboration skills need to be mastered by Biology Teacher Candidates?</td>
<td>9.8</td>
</tr>
<tr>
<td>6</td>
<td>Has your lecturer ever used group learning in lectures?</td>
<td>9.5</td>
</tr>
<tr>
<td>7</td>
<td>If you have used group learning, are there any rules in group work?</td>
<td>35.2</td>
</tr>
<tr>
<td>8</td>
<td>In your opinion, do Biology Teacher Candidates need to master creative thinking skills?</td>
<td>9.7</td>
</tr>
<tr>
<td>9</td>
<td>Has your lecturer empowered you to think creatively and collaboratively in learning Biology?</td>
<td>50.9</td>
</tr>
<tr>
<td>10</td>
<td>If yes, how often does your lecturer empower it?</td>
<td>31.4</td>
</tr>
<tr>
<td>11</td>
<td>Do you think there should be an interactive E-module based on STEM-PBL used to train the collaboration and creative thinking skills of Biology Teacher Candidates?</td>
<td>98.8</td>
</tr>
</tbody>
</table>

Table 1 shows that only 23.5% of the use of e-modules in biology learning, 98.8% of Biology Teacher Candidates consider it necessary to have an interactive e-module integrated with STEM-PBL in improving the creative thinking skills and collaboration skills of Biology Teacher Candidates. Furthermore, the survey results of the lecturer's response to the STEM-PBL integrated interactive e-module in improving creative thinking skills and collaboration skills are seen in Table 2.

Table 2. Results of data analysis of Lecturer's response

<table>
<thead>
<tr>
<th>No</th>
<th>Question Item</th>
<th>Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Do you use teaching materials in the learning process?</td>
<td>97.4</td>
</tr>
<tr>
<td>2</td>
<td>What teaching materials do you use in giving lectures? (may choose more than one option)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Textbooks: 69.2</td>
<td></td>
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<tr>
<td></td>
<td>Learning Modules: 43.6</td>
<td></td>
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<tr>
<td></td>
<td>Biology Teacher Candidate Worksheets: 46.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Textbook: 56.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E-modules: 28.2</td>
<td></td>
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<tr>
<td>3</td>
<td>If you have used E-modules, where are the E-modules used?</td>
<td></td>
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<tr>
<td></td>
<td>Make your own: 17.9</td>
<td></td>
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<tr>
<td></td>
<td>Using existing ones: 82.1</td>
<td></td>
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<tr>
<td>4</td>
<td>If you have used E-modules, what kind of E-modules are used in lectures? (if allowed to include a link to the E-modules used)</td>
<td></td>
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<tr>
<td></td>
<td>E-modules that include content that is by the scope of the material</td>
<td></td>
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<tr>
<td></td>
<td>E-modules downloaded from the internet</td>
<td></td>
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<tr>
<td></td>
<td>E-modules using the I-spring application</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Do the teaching materials that you use use the STEM approach?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes: 28.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No: 71.8</td>
<td></td>
</tr>
</tbody>
</table>
| 6  | If you have used the STEM approach, on what impact morphology, 04009 (2024)E3S Web of Conferences 482, 04009 (2024) YSSSEE 2023 https://doi.org/10.1051/e3sconf/202448204009
When using the STEM approach, what learning models/methods do you use?
- Lecture: 9,1
- Discussion: 9,1
- Problem-based learning: 27,3
- Project-based learning: 54,5

According to you, our collaboration skills are important to be mastered by Biology Teacher Candidates?

Have you ever used group learning in lectures?

If you have used group learning, are there any rules in group work?

In your opinion, do Biology Teacher Candidates need to master creative thinking skills?

If Biology Teacher Candidates need to master creative thinking skills, have you ever trained them?

If you have trained creative thinking skills, how do you train them? (you can choose more than one answer).
-  Give challenging and innovative tasks 16.2
-  Giving discussion and presentation tasks 29.7
-  Giving quizzes and exams using essay tests 8.1
-  Using discussion methods in lectures 24.3
-  Supporting models/strategies/methods that support lectures 2,7

Do you think there is a need for a STEM-based Biology module that can be used to train the collaboration and creative thinking skills of Biology Teacher Candidates?

Table 2 shows that only 28.2% of e-modules are used in biology learning, 94.9% of lecturers consider it necessary to have STEM-PBL integrated interactive e-modules in improving the creative thinking skills and collaboration skills of Biology Teacher Candidates.

Tables 1 and 2 show that the use of e-modules in biology learning is still low, and considers it necessary to have an interactive e-module integrated with STEM-PBL in improving the creative thinking skills and collaboration skills of Biology Teacher Candidates. The use of e-modules in today's technological era should have become commonplace in the learning process [38]. In addition, the use of interactive e-modules integrated with STEM-PBL can help Biology Teacher Candidates in the learning process [39].

The use of STEM-integrated PBL e-modules is packaged effectively and efficiently in supporting the learning process because STEM provides opportunities for Biology Teacher Candidates to integrate interdisciplinary such as science, technology, engineering, and mathematics in biology learning so that the skills of Biology Teacher Candidates can be developed [40,41].

Khalil & Osman (2017) and Nugroho, Permanasari, & Firman (2019) argue that STEM can improve students' 21st-century skills. The 21st-century skills of Biology Teacher Candidates that can be improved by STEM learning are creative thinking skills [40,42].

Biology Teacher Candidates are very ready to use STEM-PBL integrated interactive e-modules because all Biology Teacher Candidates have smartphones that can be used to...
The availability of interactive e-modules that integrate STEM-PBL has not been done and this follows the results of filling out a questionnaire by prospective Biology Teachers. Interactive e-modules are one of the factors that can improve the process and quality of learning to produce Biology Teacher Candidates who can master the creative thinking skills and collaboration skills of Biology Teacher Candidates. E-modules that reflect the STEM approach are expected to empower these thinking skills by integrating concepts with technological developments. To inform STEM education for benefits and ongoing investigation of the efficacies of Next Generation Science Standards (NGSS)-aligned Science Technology, Engineering, and Math (STEM) methodologies to provide more equitable opportunities to students to learn science through Arts integration (STEAM).

Teaching science through the arts with STEAM lessons is an effective approach that can be significantly improved by introducing STEM units with the STEAM-first-order effect advantage. STEM education learning activities, therefore, should give students opportunities to communicate ideas for designs. In the end, students can have appropriate competence to share ideas and projects reflecting their responsibility to solve environmental and social issues. Based on the data that has been obtained from the questionnaire of Biology Teacher Candidates and lecturers, it can be said that the availability of learning media that integrates STEM-PBL does not exist. In addition, the response of Biology Teacher Candidates to the e-module shows that there needs to be an e-module that integrates integrating STEM-PBL.

Puspitasari, Herlina, & Suyatna (2020) argue that e-modules include content in the form of videos, contain interesting images, and graphics, contain brief material, contain competency tests, contain learning instructions, use of language that is easy to understand, and contain practical simulations. Several researchers explained that an effective e-module is easily accessed by Biology Teacher Candidates anywhere and anytime with a smartphone and can help Biology Teacher Candidates understand the concept of material so that learning outcomes can be achieved.

In STEAM, the learning of school subjects is integrated, and mastering transversal competencies is explicitly stated as a learning objective. However, students can learn problem-solving (PBL) skills when engaging in collaborative invention projects; however, solving the problem is not necessarily the main aim of the invention project, but instead pursuing a pedagogical approach that supports the learning of curriculum aims holistically, including the learning of transversal competences. And master's degree, and a teaching assistant in the class. The teachers had experience in STEAM and technology education, organizing open-ended projects with transversal competences, and using scientific and engineering practices to pursue learning goals. The use of appropriate E-modules has a level of effectiveness and efficiency that supports the learning process and the achievement of learning objectives, of course, it needs development to support learning in the future, especially technology-based learning. Furthermore, Biology Teacher Candidates are interested in STEM-PBL-based e-modules because they will pay more attention to learning materials delivered through learning videos, because Biology Teacher Candidates are more interested and enthusiastic about the appearance of learning videos that are not boring.

The successful implementation of STEAM activity positively triggers the learners’ affective domains, such as attitude and motivation toward continuous learning intention in the future. So far, the learning media used during learning has always been provided by lecturers, but there are some weaknesses, namely there is only one topic of material equipped with LKS and practicum activities, most of the media only contain learning material. To be able to develop students' higher order thinking skills, the learning process must also reflect activities that empower thinking skills. Good learning media must accommodate learning activities in the classroom in order to activate the thinking ability and skills of Biology Teacher Candidates in understanding concepts.
accommodate the learning process that can foster students’ thinking skills is needed, one of which is the STEM-PBL approach. STEAM lessons could be a way to stimulate student interest in science learning and school learning in general. However, when the teachers had to elaborate on how to teach STEAM, their ideas diverged. To the two secondary teachers who never taught STEAM, STEAM was a way to extend students’ science learning to be more well-rounded in terms of content, while student problem solving or design element of STEAM was not essential. Thus, integration became, “addition of extra content to the existing science content to be covered.”

It should be noted that the implementation of PBL can improve critical thinking skills, therefore the importance of an integrated learning model to improve critical thinking skills, because the model is a scientific model, which is based on the latest issues and related to the natural science family, especially Biology subjects, then Biology Teacher Candidates can create innovation and creativity effectively so as to improve critical and creative thinking through PBL which integrates with STEM which is packaged through the use of technology-based learning media, namely e-Modules. The many desires of Biology Teacher Candidates with the availability of interactive e-modules in learning is one of the things that needs to be considered by lecturers. So far, Biology Teacher Candidates have never used learning media integrated with the STEM-PBL type. The existence of interactive e-modules is one of the benchmarks for Biology Teacher Candidates independently to determine their level of understanding of the material and demand the readiness of Biology Teacher Candidates in learning material in lectures. The existence of interactive e-modules can also facilitate learning both face-to-face and online.

4 Conclusion

Biology Teacher Candidates and lecturers need STEM-PBL integrated interactive e-modules in improving creative thinking skills and collaboration skills. Furthermore, the results of this study are recommended to be used as a strong basis for developing STEM-PBL integrated interactive e-modules in improving the creative thinking skills and collaboration skills of Biology Teacher Candidates through the Research and Development (R&D) method.

References

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