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Research Article

Development of a Computational Thinking (CT) Module to Help Pre-Service Teachers Learn How to Design CT Instruments

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Abstract.
The lack of a Computational Thinking (CT) module, which teaches how to design a CT assessment instrument causes pre-service teachers to be unable to create one. This can cause students at school to not be able to measure their achievements related to CT. This study aimed to develop a CT module to support the ability of pre-service teachers to design CT assessment instruments. This research was a development study that refers to the 4-D model, but the dissemination stage was not carried out. The research subjects were 94 pre-service teachers, 70 female students and 24 male students majoring in Biology Education in semester 4 of the academic year 2021/2022. This research instrument used a validation sheet by material experts and linguists and the test item analysis sheet with 13 criteria made by the directorate of high school development in 2010. The data analysis technique used in this study is a quantitative descriptive analysis technique. The results showed that the conclusions from the validation of the modules developed from the material and presentation aspects were an average of 88.94. The language and readability aspects were an average of 80.56, and both were in the *very good* category. In contrast, the results of the item analysis on the material, construction and language/culture aspects had a score of 77.45%, 50.29% and 84.71%. The average percentage of ability in designing assessment instruments was 70.82%. This study concluded that the module that has been developed is suitable for use and can support the ability of pre-service teachers to design CT assessment instruments.

Keywords: computational thinking, module, pre-service teachers, design, CT instruments

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1. INTRODUCTION

Computational Thinking (CT) is an important basic ability possessed by students which is as important as other basic skills such as the ability to read, write and math [1]. Supported by Adler & Kim [2] who say that practicing Computational Thinking will be useful for students in solving complex problems in everyday life. Computational thinking does not have to involve computers, but humans themselves must also have the same abilities as computers when processing information, namely by applying decomposition, pattern recognition, abstraction and algorithms [3]

The four important abilities in Computational Thinking that must be possessed by students are decomposition, recognizing patterns, abstractions and algorithms that can be used completely or not and in a systematic or non-systematic order [4] .Decomposition ability is the ability to see the structure of a problem as a whole, pattern recognition ability is the ability to recognize the same problem in different cases, abstraction ability is the ability to sort out priority and non-priority in information related to the problem, and Algorithm ability is the ability to make structured problem solving steps. The four computational thinking abilities can be trained and applied in all fields and levels of education, one example is in Biology learning [5].

The application of Computational Thinking in Biology learning in schools will be effective if it can be measured correctly through specific assessment instruments. The problem that occurs at school is that the questions provided by the teacher do not train Computational Thinking skills at all because the questions still tend to be oriented towards cognitive understanding that only tests aspects of memory [6]. It is necessary to have the ability of teachers in designing Computational Thinking assessment instruments so that the Computational Thinking-based learning process that is trained in the learning process in schools can be measured accurately.

The Department of Biology Education, FKIP, Siliwangi University is designed to create biology teachers and it must have a variety of skills to prepare them as pre-service teachers. One of these skills is learned in the Biology Learning Evaluation and Assessment course. In this course, besides being taught the concept of measurement and assessment, students are also taught to be able to design assessment instruments, one example is the Computational Thinking assessment instrument. One way to achieve this goal is to develop teaching materials in the form of modules.

Modules are teaching materials that can be in the form of print or digital which are directly used for learning activities [7]. According to Mamun [8] learning by using modules aims to enable learners to learn independently or with minimal teacher assistance. there

must be a proper module that fits the needs in order to be the answer to all the problems above. Through the use of appropriate modules, it is hoped that pre-service teachers will be motivated to learn independently in designing the Computational Thinking assessment instrument.

Based on the description above, this study aims to develop a CT module to support the ability of pre-service teachers in designing CT assessment instruments. This research was conducted because until now there is no CT module that can apply CT specifically to biology materials.

2. RESEARCH METHOD

This study uses the Research and Development (R&D) model developed by Thiagarajan, Semmel dan Semmel [9] consists of four stages known as the 4-D model (four D Model). In this study, the 4-D model only used 3-D, namely the definition stage, the design stage and the develop stage In this study, the dissemination stage was not carried out because of limited time and will be planned in future research. All stages in this research can be seen in Figure 1.

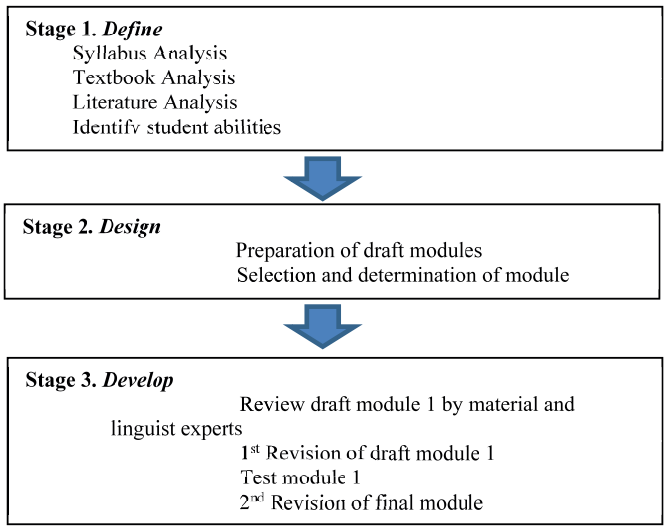


Figure 1: Research flowchart.

The subjects of this research are 94 pre-service teachers which are 70 female students and 24 male students majoring in Biology Education in semester 4 Academic Year 2021/2022 who will take part in a limited trial. The research instrument used was a material and linguist expert validation sheet and a description item analysis sheet made by the directorate of high school development in 2010 which consisted of material, construction and language/cultural aspects to see the quality of the questions that had

been made. Each aspect of the item analysis was further developed into 13 criteria for essay item analysis [10] The criteria for the analysis of essay questions are:

1. Material
2. The questions must match the indicators
3. Each question must be given Limits of expected answers
4. The material asked must be in accordance with the measurement objectives (can measure computational thinking ability)
5. The material must be appropriate to the type of school or grade level
6. Construction
7. Using question words/commands that require essay answers
8. There are clear instructions on how to answer the questions
9. Every question must have a scoring guide
10. Tables, pictures, graphs, maps or other data are presented clearly, legibly and functionally
11. Language/Culture
12. The formulation of the question sentence must be communicative
13. use standard Indonesian
14. do not use words/expressions that give rise to double interpretations or misunderstandings
15. do not use the locally applicable language/taboo
16. the question formulation does not contain offensive words.

The data analysis technique used in this study is a quantitative descriptive analysis technique, which describes the results of product development in the form of modules to support the ability of pre-service teaching in designing Computational Thinking assessment instruments. Module validation data were obtained through validation sheets from material experts and linguist experts. The validated aspects can be seen in Table 1.

To determine the level of validity of the developed learning module, the criteria used can be seen in Table 2 [11].

TABLE 1: Module validation.

	No	Aspect	Expert
	1	Computational Thinking material in the module	Material Expert
	2	Material Presentation	
	3	Language and legibility	Language Expert

TABLE 2: The development of the computational thinking module has the following results.

No	Category	Value	Percentage
1	Very Good	4	76-100
2	Good	3	51-75
3	Bad	2	26-50
4	Very Bad	1	0-25

3. RESULTS AND DISCUSSION

To get a valid module, several stages are carried out according to the 4-D model. The results obtained at each stage can be described as follows:

1) Define

This stage is carried out to see the description of course modules related to Computational Thinking, especially to analyze problems and needs seen through syllabus analysis, analysis of existing modules, literature analysis and analysis of student characteristics. The results obtained in each of these steps are as follows.

a) Syllabus Analysis

At this stage, an analysis of the syllabus of the Biology Learning Evaluation and Assessment course in the Department of Biology Education, FKIP, Siliwangi University was conducted. Based on the results of the syllabus analysis, it is known that the Competency Standards for this course are that pre-service teacher can design assessment instruments, one example is related to Computational Thinking.

b) Module Analysis

The module analysis carried out aims to determine what the contents of the module are needed by pre-service teaching of Biology. This analysis is carried out by looking at various modules in other course related to Computational Thinking. The results of the analysis show that there is no module that specifically contains guidelines for making Computational Thinking assessment instruments in Biology learning.

c) Literature Analysis

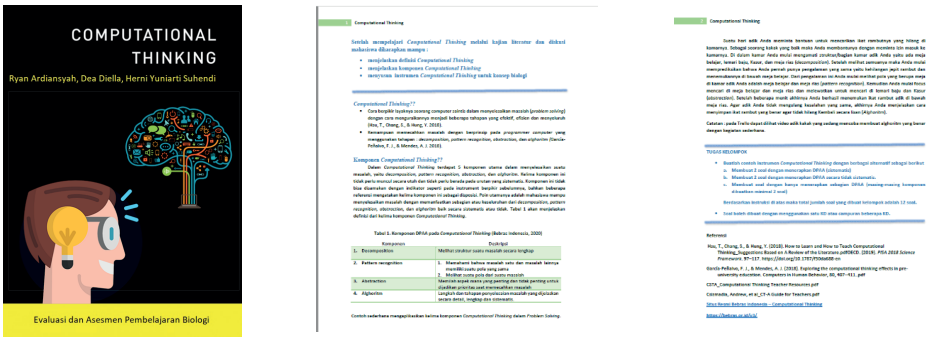
The activity of analyzing literature is an activity of collecting materials related to module design because the characteristic structure of a module is an important thing in design.

d) Student Characteristics Analysis

The modules developed are expected to be in accordance with the needs of students, so it is necessary to observe the characteristics of pre-service teacher of Biology at each course meeting. Based on observations, it is known that pre-service teacher at the Department of Biology Education, FKIP, Siliwangi University have different abilities, especially in understanding modules and designing assessment instruments. Based on these results, it is known that the characteristics of pre-service teacher in this course are easy to forget, difficult to learn without examples, and really need easy-to-understand instructions.

2) Design

At this stage the researcher designs a module based on the results of the analysis at the define stage. The module consists of cover, table of contents, learning objectives, materials, sample questions, task instructions, and bibliography. The characteristics of the designed module can be seen in Figure 2.



(a) (b) (c)

Figure 2: Characteristics of the initial design of computational thinking module.

The cover of the module is made simple with a design that describes thinking skills, one of which is computational thinking (Figure 2a). The module is also contains learning objectives that are systematically arranged, followed by simple material and presented an everyday case which makes an analogy that we are used computational thinking but are not aware of it (Figure 2b) and ends with assignments and assessments to follow up on the reader's understanding of CT and bibliography so that readers can add other information (Figure 2c)

3) Develop

a) Expert Validation

The modules that have been designed are then validated by 2 validators, namely Computational Thinking experts and linguist experts. The data from the validator's assessment were described and analyzed qualitatively and quantitatively. The results of validation by expert can be seen in Table 3.

TABLE 3: Data on the Assessment of material experts and linguists from each aspect.

Validator	Assessment Results of Each Aspect		
	Computational Thinking material in the module	**Material Presentation**	**Language and Culture**
Computational Thinking Expert	92.44	85.45	-
Average Score	88.94		
Category	Very Good		
Linguist Expert	-	-	80.56
Average Score	80.56		
Category	Very Good		

After going through both validation processes, the module is revised for the first time. The revised results were tested on 41 pre-service teaching of Biology to see the product quality of the Computational Thinking assessment instrument which was made based on the instructions in the module.

b) Quality of Essay Items

Figure 3 shows the results of the analysis of essay questions based on material, construction and language/cultural aspects.

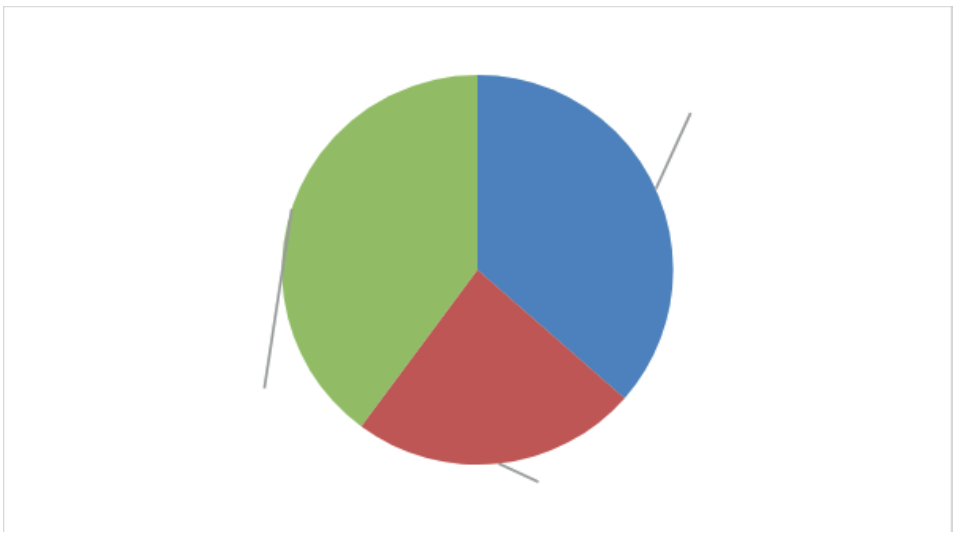


Figure 3: The results of essay questions analysis based on three aspects.

The ability of pre-service teaching of Biology in designing Computational Thinking assessment instruments in the form of essay questions from the material, construction and language/culture aspect has a percentage of 77.45%, 50.29% and 84.71%. The average percentage of ability in designing assessment instruments is 70.82%. The construction aspect has the lowest score because some of the essay questions made have inaccurate scoring guidelines.

Figure ?? shows the results of the analysis of essay items based on 13 criteria as guidelines for analyzing essay items.

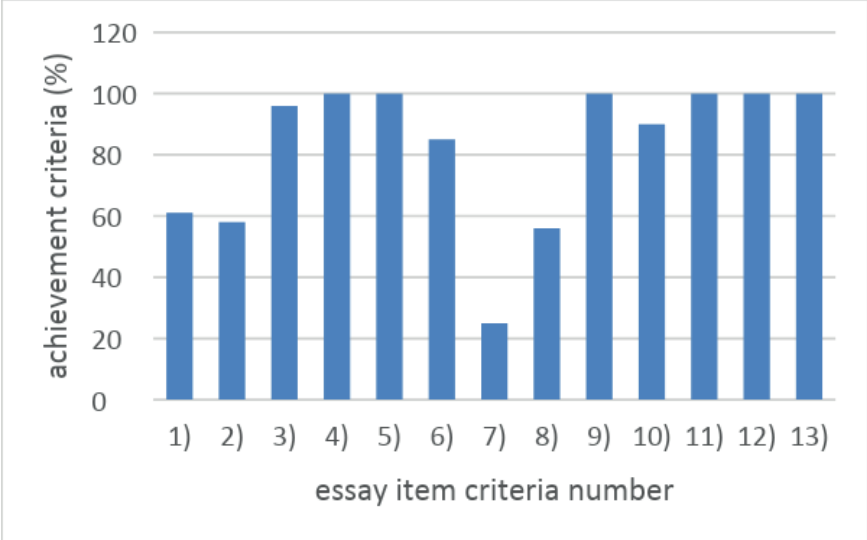


Figure 4: The results of essay questions analysis based on three aspects.

The results of the analysis show that in the material aspect, the highest criteria is achieved by criteria number 4, namely the content of the material being asked is in accordance with the school level or class grade (100%) while the lowest criteria is achieved by number 2, namely the limit of questions and answers that are expected to already exist (56.15%). In the construction aspect, the highest criteria is achieved by number 5, which uses question words that require an essay answer (100%) while the lowest criteria is achieved by number 7, namely there are scoring guidelines (25%) and number 8, namely picture tables, graphs, maps or other data have been presented. clearly and legibly (56%). In the language aspect, all criteria have been met perfectly except for criteria number 10, namely the items using standard Bahasa Indonesia (90%) but are still in the high category.

This CT module utilizes case studies that can analogize the application of CT in everyday life so as to be able to explain the concept of CT in a simple and easy-to-understand way. The developed CT module has a function and deserves to be used properly because the provision of examples, cases, and several tasks in a module can

make it easier for readers to understand the contents of the module [12]. The developed CT module can still fulfill the various characteristics of the ideal module, namely formulating learning objectives systematically, packaging learning materials into small and specific units so that it makes it easier for students to study thoroughly, providing examples and illustrations to support clarity in the presentation of learning materials, and presenting Practice questions that allow students to respond and measure their understanding [13].

The validation results also state that the developed CT module has met the principles of ideal module preparation, including the language module is interesting and stimulates students to think, the module is adjusted to the level of student ability and is able to provide opportunities for students to complete individually [14]. The concepts available in this module only include the CT concept, where the CT concept is very important for students, especially in solving all problems related to their daily lives by applying the CT Steps, namely decomposition, pattern recognition, abstraction and algorithms [15]. These four steps must be owned by students who are studying in the current era where technology is growing rapidly [16].

4. CONCLUSION

Based on the results of this study, it can be concluded that the Computational Thinking module that has been developed is considered feasible by experts to be used in the learning process in the Biology Learning Evaluation and Assessment course. The module that has been developed oriented to Computational Thinking can support the ability of pre-service teachers of Biology in designing a Computational Thinking assessment instrument based on the results of the analysis using 13 criteria from the guideline for item analysis. Some suggestions from the results of this study are the Computational Thinking module which will use next as a reference for pre-service teacher of Biology, must be consist of instructions on how to develop scoring guidelines in detail and there needs a module that can support the ability of pre-service teacher in designing other thinking assessment instruments and other subjects

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