



## **Socioscientific Issues-based Textbook on the Topic of Sustainable Development Goals to Develop Prospective Teachers' 21<sup>st</sup> Century Thinking Skills**

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**Abstract.** The emergence of the 4.0 industrial revolution requires university graduates to have 21st-century thinking skills that can support them to compete globally. However, the low 21st-century thinking skills of prospective teachers in the group of ways of thinking (critical thinking, problem-solving, and decision making) make the learning process should be able to train and develop these thinking skills. One way to train prospective teachers' 21st-century thinking skills is through the textbooks used in lectures. This study aims to develop textbooks based on socioscientific issues on the topic of Sustainable Development Goals (SDGs). This study used the R&D research method with ADDIE design which is composed of 5 stages: Analyze, Design, Develop, Implement, and Evaluate. textbooks were applied at the implementation stage by involving second-semester prospective teachers who contract Environmental Knowledge courses. The instruments used in this study included textbook validation sheets and essay tests. The validation results were analyzed using descriptive analysis, while the essay test results were analyzed using SPSS. The results of the study showed that the socioscientific issues-based textbooks on the SDGs topic received a very good expert assessment and had met the standards of the appropriateness of the content, language, graphics, presentation, and socioscientific issues. Prospective teachers' 21st-century thinking skills in the group of the way of thinking also improved significantly after using socioscientific issues-based textbooks. These indicated that the textbooks which have been developed were effective in practicing the 21st-century thinking skills of prospective teachers.

**Keywords:** Socioscientific issues, textbook, SDGs, 21<sup>st</sup> Century Thinking Skills

### **Introduction**

The industrial revolution 4.0 is the era of the fourth world revolution marked by several new technologies that combine the physical, digital and biological worlds, which affect all disciplines of life including economic and industrial aspects (Schwab, 2018). In this era, employment does not only require individuals who have extensive knowledge, but also need individuals who have analytical thinking skills, digital skills, and communication skills (Chu, et al., 2017). This condition makes university graduates must have thinking skills that can support them to compete globally, namely 21st-century thinking skills. Griffin, et al. (2012) revealed that 21st-century skills are the types of skills needed by a person to live in the 21st century. These skills include skills in ways of thinking (such as critical thinking, making decisions, solving problems), ways of working (communication, collaboration), tools for working (ICT and information literacy), and living in the world (such as personal and social responsibility) (Binkley, et al., 2012). Prospective teachers need to have 21st-century thinking skills because these skills can help them become effective

teachers, be able to carry out the inquiry process, and overcome problems in their practice (OECD, 2015). Besides, with increasingly sophisticated technology, prospective teachers in the 21st century must also be able to deal with pieces of information from various sources quickly, especially on socioscientific issues (McDonald, 2014).

Socioscientific issues are complex, contemporary, usually ill-structured, related to social aspects that are often debated and have no absolute solution (Christenson et al., 2016). This is due to the complex nature of socioscientific issues and involves multiple perspectives and values (Chung, et al., 2014). Herawati & Ardianto's research results (2017) showed that most prospective teachers were still unable to identify and extract data on detailed information so they have difficulty making logical decisions and arguments when faced with socioscientific issues. Istiana, et al. (2017) also showed that students' ability to solve environmental problems was still low even though the ability to reason and solve problems is important for students to master in this century. Engaging students in the socioscientific issues has been carried out through the argumentation real-world inquiry model (Istiana, et al, 2020). Students were stimulated to make decisions and put forward their arguments related to environmental socioscientific issues, but the ability to explore and evaluate data or information still needed to be built. This indicates that the learning model that emphasizes the socioscientific issue is not sufficient to build and improve prospective teachers' 21st-century thinking skills so that a learning resource is needed that complements the learning process in the form of textbook.

Textbooks have an important role in the learning process as a learning resource (Daryanto, 2014). Textbooks as teaching materials help students to achieve the specified competency standards because they contain elements of knowledge, skills, and attitudes that students must learn (Nurdin & Adriantoni, 2016). Besides, textbooks also need to bring up phenomena, data, and facts that can stimulate the development of students' thinking abilities (Reece & Walker, 1997). One of the efforts to present phenomena, data, and facts in textbooks is the insertion of socioscientific issues such as SDGs issues. SDGs issues need to be embedded in textbooks and implemented in the lecture process. This is because the SDGs can be achieved through contributions from the university as higher education system (Zhou, et al., 2019). Higher education institutions have a crucial role in facing the challenges of sustainable development by increasing training and skills development (Nhamo & Mjimba, 2019). Owens (Nhamo & Mjimba, 2019) revealed that a higher education institute should not only produce great teachers but also produce innovative researchers and provide services to the community.

The socioscientific issue-based textbooks developed in this study are textbooks on sustainable development goals (SDGs) which are equipped with the context of SDGs issues in each component. The existence of the insertion of socioscientific issues is important because the involvement of prospective teachers in socioscientific issues provides an opportunity for them to be able to apply scientific concepts, principles, and scientific practice to issues that are influenced by social, political, and even economic considerations (McDonald, 2017). Thus, prospective teachers are involved in the process of proposing arguments, making decisions, and solving problems related to the socioscientific issues faced, especially the SDGs issue that occurs in Indonesia. However, there has been no research that developed textbooks in the form of textbooks based on socioscientific issues on the topic of SDGs so this provides an opportunity for researchers to develop textbooks that involve SDGs issues that occur in Indonesia as textbook to train prospective teachers' 21st-century thinking skills.

## Methods

This study used the research and development (R&D) method with the ADDIE model (analyze, design, develop, implement, and evaluate). The research was conducted at a private university in Bogor City. The research subjects included second-semester prospective biology teachers who contracted the Environmental Knowledge course in the Odd Semester of the 2019/2020 Academic Year.

The textbook developed in this research was on the topic of Sustainable Development Goals (SDGs) with the title "Isu Sosiosaintifik dalam Konteks SDGs". The development of textbook is carried out according to the ADDIE model research stage procedure which is composed of 5 stages: 1) **The analyze stage**, researchers analyze the curriculum for environmental knowledge courses, student academic abilities, lecture books, and indicators of 21st-century thinking skills in the group of ways of thinking (critical thinking, making decisions, and solving problems); 2) **The design stage**, researchers designed the learning objectives, textbook components, feasibility instruments for textbook, and instruments for the 21st century thinking skills in the ways of thinking group; 3) **The develop stage**, the compilation of textbooks is carried out, validation of textbooks to experts (on aspects of content, language, presentation, graphics, and socio-scientific issues), validation of 21st century thinking skills essay instruments for ways of thinking groups, textbook readability trials and instrument questions for students who are not research subjects, as well as revising textbooks based on test results; 4) **The implement stage**, environmental knowledge lectures were carried out for 4 meetings using textbooks based on socio-scientific issues, and the 21st-century thinking skills of biology prospective teachers' were measured before and after the lecture. The implementation of textbooks at this stage involves one experimental class with a one group pretest-posttest design; 5) **The evaluate stage**, data analysis and evaluation activities were carried out related to the effectiveness of using socioscientific issue-based textbooks during the learning process towards prospective teachers' 21st-century thinking skills.

The 21st-century thinking skills of prospective teachers' measured in this study were the groups of ways of thinking (critical thinking, problem solving, and decision making). Indicators of thinking skills in the 21st-century for groups of ways of thinking (Table 1) in this study were adapted from Binkley, et al. (2012) and presented in 7 essay questions based on two news articles related to the SDGs topic. The subtopic raised in the test instrument is climate change with the issue of "Reducing Beef Consumption" and the conservation of marine natural resources with the issue of "Underwater Threats of Raja Ampat". The ways of thinking of 21st-century thinking skills adapted from Binkley, et al. (2012) positioned the skills of critical thinking, problem solving, and decision making into one group with aspects of knowledge, skills, and attitudes. However, the essay test instrument in this research only included the knowledge and skills aspect.

**Table 1.** Ways of thinking (critical thinking, problem solving, decision making)

No.	Aspects	Indicators
1.	Knowledge	<p><b>Reason effectively, use systematic thinking and evaluate evidence</b></p> <ul style="list-style-type: none"> <li>● Understand the importance of evidence in belief information.</li> </ul> <p><b>Solve problems</b></p> <ul style="list-style-type: none"> <li>● Ask significant questions that clarify various points of view and lead to better solutions.</li> </ul>
2.	Skills	<p><b>Reason effectively</b></p> <ul style="list-style-type: none"> <li>● Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation.</li> </ul>

No.	Aspects	Indicators
		<p><b>Use systems thinking</b></p> <ul style="list-style-type: none"> <li>● Effectively analyze and evaluate evidence, arguments, claims, and beliefs.</li> <li>● Examine ideas, identify, and analyze arguments.</li> <li>● Synthesize and make connections between information and arguments.</li> <li>● Interpret information and draw conclusions based on the best analysis.</li> </ul>

The feasibility of textbook based on socioscientific issues is obtained from the assessment of experts using validation sheet instruments. The calculation of the feasibility of textbooks used the formula of percentage score. The results of the calculations were then categorized based on the validity criteria of the textbook presented in Table 2.

**Table 2.** The Validity Criteria of the textbook

No.	Score	Qualification
1.	80 - 100	Valid
2.	60 - 79	Quite Valid
3.	40 - 59	Less Valid
4.	0 - 39	Invalid

(Arikunto, 2013)

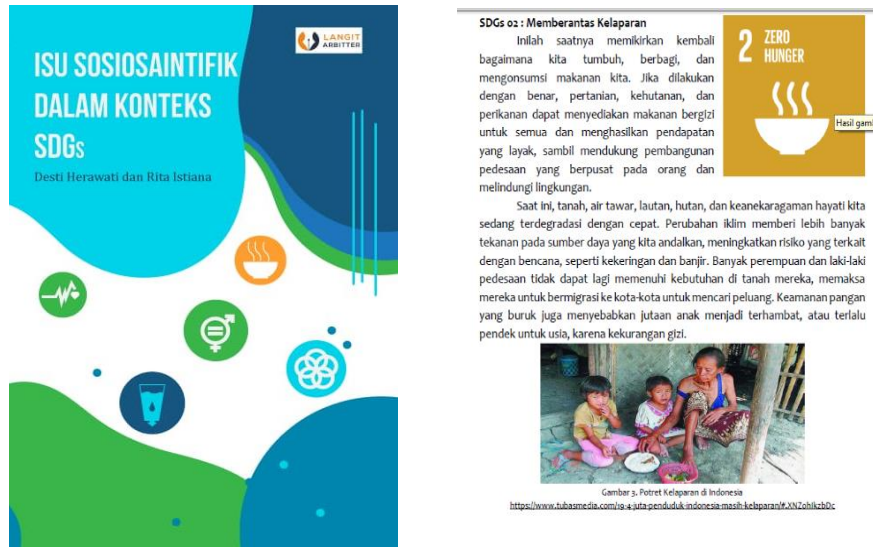
Data on prospective teachers' 21st-century thinking skills were analyzed using the N-Gain value through SPSS software for normality test, homogeneity test, and Wilcoxon test.

## Results and Discussion

The ability to think can be trained during the learning process, one of which is through textbooks. Textbooks play a role in helping lecturers in carrying out learning activities and supporting the success of students in mastering learning materials and developing their thinking skills (Pratiwi, et al., 2014; Nurdin & Adriantoni; 2016). In the analysis research stage, researchers examined textbooks that are often used in the Environmental Knowledge course and the results showed that textbooks were dominated by the material presented and several questions to explore conceptual understanding. In these textbooks, there are no issues related to the material context to stimulate students' thinking skills. Most of the students' abilities are not able to criticize environmental problems in Indonesia, dig up valid information, and convey problem-solving ideas. Thus, the textbook developed in this study focuses on the insertion of socioscientific issues related to the SDGs context that occurs in Indonesia as well as questions to train students' 21st-century thinking skills. The questions that will be used in the research are designed at the design stage. The research instrument which is composed of questions to measure 21st-century thinking skills of the ways of thinking group has been validated by evaluation experts and declared fit for use after the revision of question construction.

The development of textbook design and features is carried out at the Develop stage. This textbook has several features that are based on indicators of learning achievement related to 21st-century thinking skills of ways of thinking (Table 1). The first feature in the

textbook is the SDGs material which includes the first to seventeenth sustainable development goals (Figure 1).



**Figure 1.** Book cover and Content features of SDGs

In the content feature, materials for each type of SDGs are presented, the national level sustainable development achievement targets, and the achievement targets at the global level. The presentation of content along with the target achievement for each type of SDGs is intended so that students can understand the underlying problems of each type of SDGs and target outcomes to overcome these problems, especially those that occur in Indonesia. The presentation of contextual issues in textbooks aims to make students better understand the material and its problems through real situations. As stated by Khoiron & Sutadji (2016), the learning process involving contextual issues stimulates students to use a scientific approach, relates material content to real-life conditions, and applies it in daily life.

The textbook being developed also has a Discussion feature (Figure 2). In the Discussion feature, there are issues related to each type of SDGs obtained from national news. Also, there are several questions based on the issue discourse presented to train students to identify problems, seek further evidence and explanations, make decisions, and propose solution ideas. These questions were developed from the discourse on SDGs to train students' 21st-century thinking skills in the way of thinking group. Cognitive skills to think critically, systematically, and creatively, which involve various approaches, perspectives, and views on an issue, such as problem-solving skills need to be trained in the learning process (Bourn, 2018). The discussion feature on SDGs issues related to the environment in Indonesia stimulates students to be able to investigate problems, connect relevant concepts so that they can make decisions on these problems. The results of Fadly & Miaturrohmah's research (2021) also show that the feature of investigating environmental problems can help students to construct logical thinking and creativity in connecting environmental problems and scientific concepts that involve multi-disciplinary integration. Besides, the presentation of problems in learning activities is also able to trigger students to think critically (Rezkillah & Haryanto, 2020).

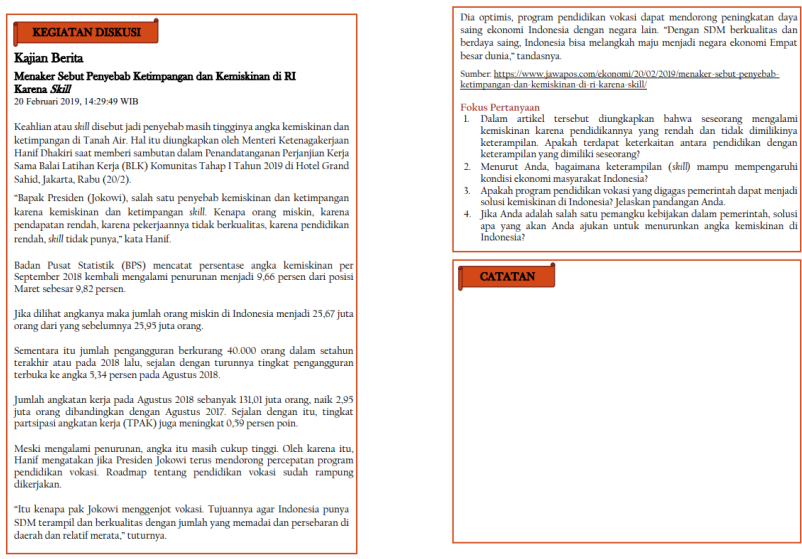


Figure 2. Discussion Features of SDGs Issues

Textbooks that have been compiled are then validated by 1 material expert and 2 instructional media experts. This validation aims to determine the feasibility of textbooks in terms of content, language, presentation, graphics, and socio-scientific issues. The results of the textbook validation that have been developed can be seen in Table 3.

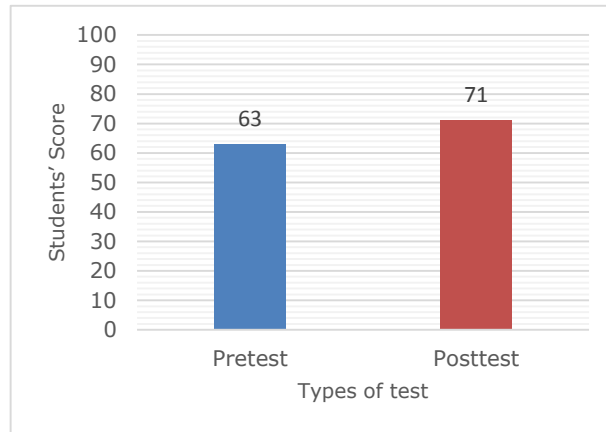
Tabel 3. The Results of Validation of Textbook

No	Aspects of Assessment	Average Score	Criteria
1	Content Feasibility	85	Good
2	Language Feasibility	81	Good
3	Presentation Feasibility	80	Good
4	Graphic Feasibility	82	Good
5	Socioscientific Issues Feasibility	87	Very Good
Average		83	Goof

The results of expert validation (Table 2) indicate that the textbook has met the feasibility standards for content, language, presentation, graphics, and socioscientific issues. Besides, the elements of socioscientific issues contained in the textbook are also following the SDGs material studied by students. Before being used on research subjects, textbooks were tested for legibility on non-research subjects who had contracted the Environmental Knowledge course in the previous year. The readability test aims to determine the extent to which the textbooks developed can be understood and used by students based on language elements, information ideas, and presentation. The legibility test results showed that most students (99%) gave positive responses to textbooks. textbooks use elements of letters, sentences, and clear language, attractive writing graphics, and the presentation of material that is easy for them to understand.

Textbook that has been revised based on the results of expert validation and legibility tests are then implemented in lectures. Students' 21st-century thinking skills on the SDGs issue of climate change and marine conservation issues were measured before

and after they learned to use textbooks. The results of the students' ways of thinking group test are presented in Figure 3.



**Figure 3.** Students' 21st Century Thinking Skills on Socioscientific Issues

The effectiveness of textbooks on students' 21st century thinking skill in the ways of thinking group was statistically tested using the Wilcoxon Test. The Wilcoxon test results obtained a Sig value of  $0.000 < 0.05$ . This showed that there was a significant difference between the thinking skills of 21st-century students before and after using socioscientific-based textbook.

The measurement results of students' 21st-century thinking skills showed that the use of socioscientific issue-based textbook on SDGs material effectively improves students' thinking skills (critical thinking, problem solving, and decision making). This can be seen from the improvement of students' thinking skills after using textbooks during lectures. The results showed that the insertion of socioscientific issues related to the SDGs context in textbooks was able to stimulate students to be able to think actively, seek solutions to problems, and make considerations and decisions on policies and conditions that occur in the implementation of SDGs in Indonesia. The use of socioscientific issues during learning process stimulates students to be able to expose problems explicitly or implicitly by involving differences in social, moral, and scientific concepts on issues that are following or contrary to their beliefs (Zeidler, et al., 2005). Socioscientific issues can also help students to improve critical thinking skills, decision-making skills, have moral sensitivity, and trigger conceptualizations about the nature of knowledge (Sadler, 2004; Sadler & Zeidler, 2005; Sadler, et al., 2016) where these skills are very much needed in the 21st century. Tidemand and Nielsen (2016) also revealed that teaching involving socioscientific issues can develop critical thinking skills, decision-making skills, argumentation skills, moral development, and student learning outcomes.

The context of the SDGs material needs to be studied by students in lecturing activities, especially in the Environmental Knowledge course. This is because the SDGs represent a statement of commitment from the global community until 2030 (McCowan, 2019) so that students today do not only know the types of SDGs but they must be able to respond to SDGs issues that occur both nationally and globally. Training 21st-century thinking skills in the context of the SDGs is important because universities are responsible for shaping future generations with essential knowledge and skills so that they can play an active role in SDGs policies and practices (Franco, et al., 2018). Education at the university level also has an important role in the SDGs, namely as a control to achieve goals in education through knowledge formation and innovation (Chankseliani & McCowan, 2021).

Therefore, SDGs contextual issues have the potential to be used in learning activities to improve students' knowledge and thinking skills.

## Conclusion

The textbook based on socioscientific issues of the SDGs have received expert validation in both categories for elements of feasibility of content, language, graphics, presentation, and socioscientific issues. Textbook can also be understood by students (prospective teachers) both in terms of language, material presentation, and graphics. The textbook developed was able to effectively improve the 21st-century thinking skills of students in the ways of thinking group. This indicates that the 21st-century thinking skills of prospective teachers in the ways of thinking (critical thinking, problem-solving, and decision making) can be trained through the learning resources which they used in the course.

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