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The development measurement of environmental literacy and ethics instrument for adults education

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Abstract--This development research aims at determining validity measurement of environmental literacy and environmental ethics instruments. Assessment of environmental literacy is considered important to determine students' ability to understand environmental concepts and to apply that knowledge in every action in their daily lives is. Meanwhile, environmental ethics assessment is intended to find out the attitudes and behavior of students towards the surrounding environment. This is a development research using the Orondo and Dallo-Antonio's model, which was modified according to development needs, consisting of the initial planning and drafting stage of the instrument, the validation and trial, and the final instrument preparation. The validity analysis of environmental literacy

instruments was carried out in two stages, namely content validity and construct validity, while that of the environmental ethics instrument was undertaken by using the Aiken 'V' Validity Coefficient and inter rater reliability. The environmental literacy instrument was declared valid and all items (22 items) could be used, with a very high test reliability test ($r\text{-Spearman} = 0.950$). Meanwhile, the environmental ethics instrument was stated to have moderate validity with Aiken index of 0.794 and Cronbach's Alpha reliability of 0.883, so that both instruments were worthy of being used for retrieving research data.

Keywords---Environmental ethics, Environmental literacy, Evaluation tools, Instrument, Research & development.

1 Introduction

Nature and the environment provide various benefits for human life and civilization. One form of utilization carried out by humans is in the field of tourism. A person's ecological view is generally a subjective belief about the relationship between humans and nature that forms certain basic concepts related to attitudes, beliefs, and behavior towards the environment (Lwo et al., 2017). Utilization of nature and the environment as natural tourism objects and destinations has an impact on increasing and accelerating economic development, job creation and investment in the cheapest category (Buccellato et al., 2010; Hakan et al., 2015; Veisi et al., 2019). However, if this development and utilization is not managed wisely and is exploited excessively, it will have an impact on environmental damage on a larger and wider scale, which will eventually break the economic chain for the community itself. Therefore, for the sake of environmental sustainability for future generations, it is deemed necessary to introduce environmental literacy and ethics to every individual, starting from the world of education. The environmental literacy term mentioned by (The Texas Natural Resource/Environmental Literacy Plan, 2017) stated environmental literacy is knowledge, skills and the ability to understand, analyze opportunities and overcome challenges in natural resources. The North American Association for Environmental Education (NAAEE) uses the environmental literacy term to include knowledge, abilities, dispositions, and behaviors that allow students to make decisions and act to overcome environmental problems. (Artun, 2016) states that individuals can be said to have good environmental literacy skills if they provide solutions to environmental problems, investigate events, use technology in the process of finding solutions. In fact, individuals with all abilities are considered to have good environmental literacy skills, if they can become individual innovators. Thus environmental education is one of the most promising research areas for improving environmental literacy (Atabek-Yigit et al., 2014; Boca & Saraçlı, 2019).

Environmental literacy cannot be separated from environmental ethics because basically the competencies and objectives of environmental literacy foster attitudes and behaviors concerning with the environment. Contended environmental ethics is a discipline focusing on the way humans treat nature

(Marfai, 2019; Veisi et al., 2019; Wapner & Matthew, 2009) also explained environmental ethics does not only talk about human behavior towards nature, but also about the relations between all life in the universe, namely the relationship among humans that affects nature, human relations with other living things or with nature overall.

Based on the mandate of the Law of the Republic of Indonesia No. 32 of 2009 concerning Environmental Protection and Management, especially Article 65 paragraph 2, states that one of the rights of the community is to receive environmental education. In this regard, various efforts have been made to support the implementation of environmental education, one of which is to develop instruments that can be used to evaluate the learning process related to one's environmental literacy and ethics. The assessment instrument developed certainly has a specific objective and purpose. We can simply mention that the assessment instrument is a tool used by educators as a reference in giving conclusions to the teaching and learning process. (Voulvoulis & Burgman, 2019) stated that the assessment carried out by educators provides feedback about the effectiveness of teaching and gives students the results of the progress of their studies. The development of environmental literacy and ethics instruments is intended to measure knowledge, attitudes, behaviors, and skills (Chu et al., 2007; Wardani et al., 2018; Yalcin & Yalcin, 2017). At this time the complexity of environmental problems in various countries. However, there is still a lack of research on how to reduce the effects of environmental problems. Some studies have focused on eliminating the effects of environmental problems, while others have considered preventing these problems because it is an easier and more effective way. Environmental education is one of the fields of research that is needed in preventing the impact of environmental problems ((Ardoin et al., 2020; Ergin, 2019).

The main reason for environmental problems is the unconscious human activity (Gündüz, 1998). For this reason, humans must take responsibility for providing solutions. Therefore, through the development of literacy and environmental ethics instruments in the educational process, it is hoped that it will increase environmental awareness to wisely manage the environment with good ethics. The most important way to solve environmental problems is by environmental education and producing students who have environmental literacy and environmental ethics. Thus, the literacy must be determined and developed. There has been a lot of research on the development and validation of environmental related instruments. For example, (Yeşilyurt et al., 2013) have developed an instrument to determine student attitudes towards environmental problems. (Özsevgeç et al., 2010) developed the environmental literacy scale for prospective teachers. (Uzun & Sağlam, 2006) developed an environmental attitude scale for high school students.

This development research was carried out to determine the construction of environmental literacy and environmental ethics instruments. Environmental literacy assessment is considered important to determine the extent to which students' ability to understand environmental concepts and apply that knowledge in every action in their daily lives is. Nevertheless, environmental ethics

assessment is intended to find out the attitudes and behavior of students towards the surrounding environment.

This development research aims at determining validity measurement of environmental literacy and environmental ethics instruments. Assessment of environmental literacy is considered important to determine students' ability to understand environmental concepts and to apply that knowledge in every action in their daily lives. Thus, the question of this research is how are the results of the measurement of the validation of environmental literacy instruments and environmental ethics instruments for adults' education..

2 Materials and Methods

General Background

This development research aims at determining the construction of environmental literacy and ethics instruments. The instruments produced in this development research were test and non-test instruments. The development of this environmental literacy and ethics instruments was carried out by employing the (Oreondo & Antonio, 1984), which was modified according to development needs, consisting of the initial planning and drafting stage of the instrument, the validation and trial stages, and the final instrument preparation stage. The steps to develop an instrument for environmental literacy and ethics assessment are shown in Figure 1.

The subjects were selected by using purposive sampling method in which they were chosen if they had passed basic ecology class. Specifically, in this case, the subjects had passed Ecology and Environmental Problems class, so that they have an initial understanding of environmental issues. The subjects in this study were biology education students at one of the LPTK in Banda Aceh City.

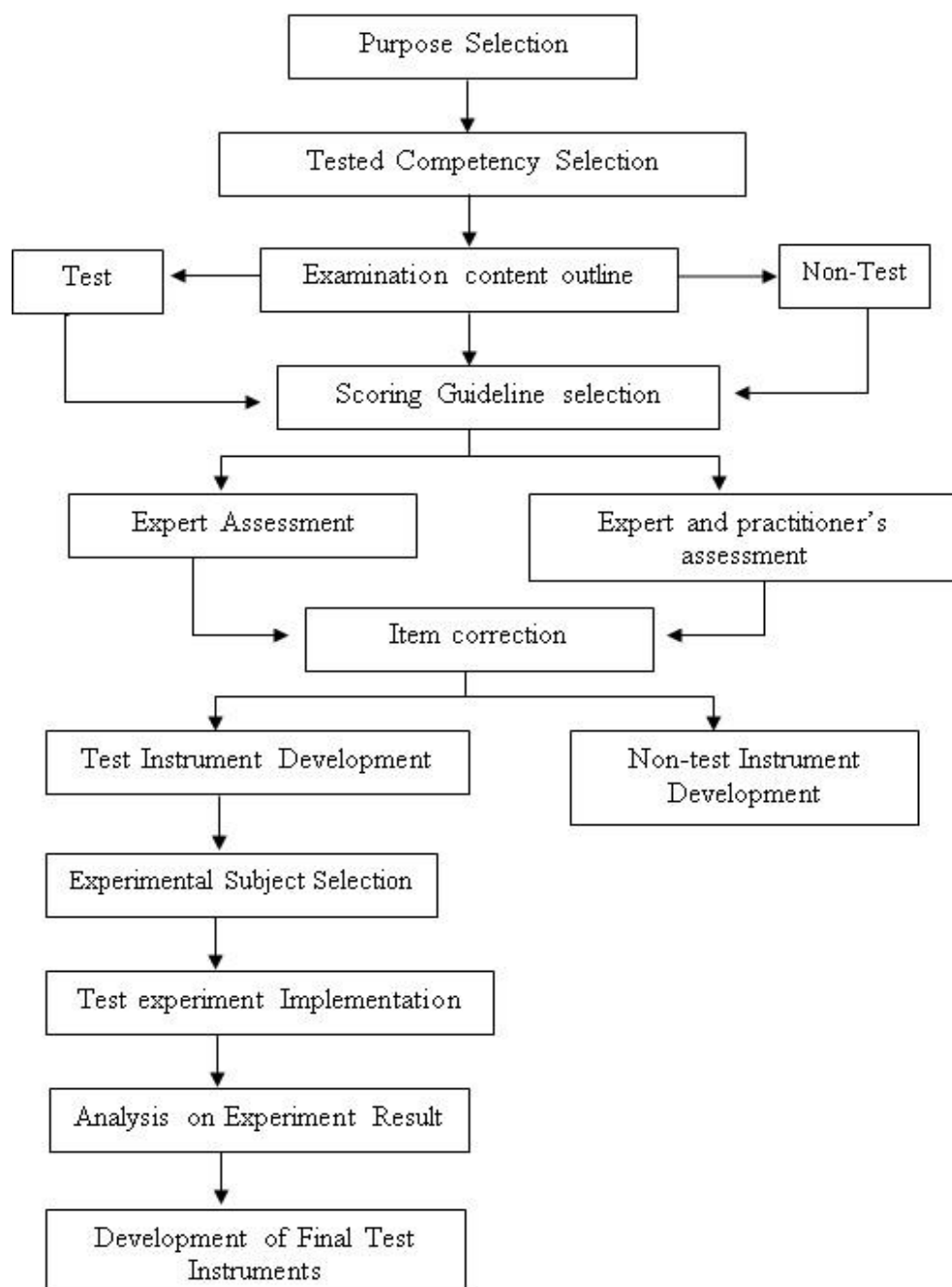


Figure 1. Steps for developing instruments for environmental literacy and ethics

Participants

This study involved six experts to validate environmental literacy and environmental ethics instruments. The experts consist of six experts in measuring biology education from Yogyakarta State University, Indonesia, Universitas Serambi Mekkah, Indonesia, Syiah Kuala University, Indonesia, and UIN Ar-

Raniry Indonesia. This study also involved 150 students as a sample at one of the universities in Banda Aceh, Indonesia. Sampling in this study used a cluster sampling technique to determine samples that were not based on individuals but based on class groups.

Instrument and Procedures

Determination of the tested instruments and the grid of each instrument is carried out through a screening process involving experts with focus group discussion techniques. Assessment analysis on the validity of environmental literacy test was done by using expert tests, namely by conducting content validity to measure the accuracy of the learning material used and construct validity to figure out the consistency of the question. The formula used for the construct test are pearson product moment, level of difficulty, discriminating power shown, spearman brown reliability correlation test (Stiggins, 1994; Turney & Thomas, 1972). The validity of environmental ethics instruments was developed by using the Content Validity Coefficient - Aiken's V (Aiken, 1985). Furthermore, the measurement of inter-rater reliability of the assessment results of environmental ethical instruments was conducted by experts. The developed environmental literacy outline as an indicator for compiling research instruments is presented in Table 1.

Table 1
Content outline of enviromental literacy test items

Compotency	Specific Compenents	Indicators	Item No.
Knowledge	Ecological knowledge	Knowledge about:	1
		Physical and ecological systems	2
		Issues related to the environment	5
		Some solutions to environmental problems	10
		Strategies for community participation and action	11
			12
			13
Attitude	- Verbal Commitment - Enviromental Sensitivity	Having sensitivity	4
		Attitude and concern with the environment	7
		Assumption of personal responsibility	15
		Locus of control / Self-efficacy	17
		Motivation, and intention to act	
Cognitive Skill	- Plan for Issue Investigation - Identification of Issues - Issue Analysis	Identifying environmental problems	3
		Analyzing environmental problems	6
		Investigating environmental problems	8
		Evaluating and making personal judgments about environmental issues	9
		Using evidence and knowledge to choose and maintain something in solving problems	16
Behavior	Real Commitment (Pro-Environment Actions)	Involvement in intentional behavior and habits, individually or collectively, which works to solve current problems and prevent new problems	18
			19
			20

The content outline of environmental ethics instruments is shown in Table 2 below.

Table 2
Content outline for environmental ethics assessment

Environmental Ethics Principles	Indicators	Conservation Actions	Item No.
Respect for nature	• Having a moral obligation to respect fellow human being. • Having a moral obligation to respect other human. • Having a moral obligation to respect nature and the environment	Taking Care	1
		Maintaining	3
			5
Responsibility Principles	• Working together (or individuals) to protect and preserve nature • Working together (or individuals) to prevent natural damage • Working together (or individuals) to restore damage to nature • Reminding each other in protecting and preventing damage to nature	Taking care	4
		Maintaining	6
		Improving	9
			13
No Harm Principles	• Having attitudes and actions that do not harm and threaten other living things in nature • Having attitudes and actions that look after, protect, take care and preserve nature	Taking care	2
		Maintaining	7
		Improving	11
Compassion for and concern with nature principles	• Having love and concern with nature and other living things	Improving	15
		Taking Care	8
Cosmic solidarity principles	• Having self control to avoid behavior that damages the environment • Having an attitude that opposes any actions that damage nature	Maintaining	14
		Taking Care	10
		Maintaining	12

Data Analysis

The Statistical Package for the Social Sciences (SPSS, version 22.0) was used to analyse the data. After eliminating the forms that were thought to be involuntary responses, item analyses were accomplished. Reliability analyses were done using the calculation of Cronbach's Alpha coefficient and split-half reliability coefficient that measured the internal consistency estimates of the test scores of the scale.

3 Results and Discussions

Measurement of Environmental Literacy Instrument

The description of each instrument that has been successfully developed is presented as follows. Environmental literacy instruments are in written tests in the form of multiple choices with 5 alternative choices (A, B, C, D, and E), which consists of 22 test items. This environmental literacy instrument is used to determine whether or not there are changes in students' environmental literacy after they experience the learning process about the environment.

The initial assessment (content validity) of 20 items was through expert expertise assessment, by giving a check (√) in the "valid" or "invalid" column. The results of the initial assessment can be concluded that the test questions compiled are valid and can be used after experiencing some improvements and changes, both from the structure of the sentence, language, and question displays.

Table 3
Expert assessment of environmental literacy test items

No	Suggestion	Item No.	Summary
1	Improving the completeness of the structure of words and sentences used	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	Every part of questions can be applied to assess the environmental literacy after revising.
2	Simplifying sentences that are too long to save time	1, 2, 3, 8, 11, 13, 18	
3	Paying attention to the consistency of the question	1, 2, 3, 7, 8, 10, 11, 12, 15, 17, 18, 20	
4	The size of the image must be proportional	9, 19	
5	Adding item items to materials that is considered lacking	21, 22	

Furthermore, the advice given is related to the addition of items to the material that was considered still lacking. Thus, the questions that initially only contained 20 items were revised to become 22 items. Two items of questions that had been added to the environmental literacy test were classified as ecological knowledge competencies. The part of revised questions are remade to be a new instrument test. The instrument of this test was then tested its construct validity to the subject so that the questions became valid and worthy of being used as an evaluation tool. The results of the test validity on the questions are shown in Table 4.

Table 4
Test results for the developed environmental literacy tests

Item No.	Item Validity		Level of Difficulty		Item Discrimination		Summary
	(r)	Category	Number	Category	Number	Category	
1	0,575	Moderate	0,683	Moderate	0,300	Sufficient	T*
2	0,646	High	0,317	Moderate	0,233	Sufficient	T*
3	0,547	Moderate	0,700	Moderate	0,267	Sufficient	T*
4	0,776	High	0,683	Moderate	0,500	Good	T*
5	0,677	High	0,667	Moderate	0,467	Good	T*
6	0,596	Moderate	0,333	Moderate	0,267	Sufficient	T*
7	0,623	High	0,317	Moderate	0,367	Sufficient	T*
8	0,682	High	0,350	Moderate	0,367	Sufficient	T*
9	0,640	High	0,317	Moderate	0,367	Sufficient	T*
10	0,445	Moderate	0,317	Moderate	0,233	Sufficient	T*
11	0,490	Moderate	0,667	Moderate	0,400	Sufficient	T*
12	0,623	High	0,317	Moderate	0,300	Sufficient	T*
13	0,768	High	0,667	Moderate	0,533	Good	T*
14	0,684	High	0,683	Moderate	0,433	Good	T*
15	0,682	High	0,350	Moderate	0,367	Sufficient	T*
16	0,517	Moderate	0,600	Moderate	0,267	Sufficient	T*
17	0,692	High	0,333	Moderate	0,400	Sufficient	T*
18	0,519	Moderate	0,667	Moderate	0,333	Sufficient	T*
19	0,535	Moderate	0,683	Moderate	0,367	Sufficient	T*
20	0,559	Moderate	0,700	Moderate	0,333	Sufficient	T*
21	0,462	Moderate	0,667	Moderate	0,267	Sufficient	T*
22	0,594	Moderate	0,317	Moderate	0,300	Sufficient	T*
Test Reliability Assessment = Very High (r-Spearman = 0.950)							
The number of questions used = 22							
The number of questions eliminated = 0							

Description: T* = Test items can be used.

Measurement of Enviromental Ethics Instrument

Environmental ethics instruments developed were in the form of observation sheets, consisting of 15 items where the assessor/observer who will use this instrument can give an assessment by giving points "1" or "0" in accordance with the activities carried out by students. Point one is given for activities that have been carried out/implemented and "point 0" for activities that have not been carried out/ have not been implemented. This environmental ethics instrument is used to find out how students behave towards the environment during their participation in the learning process about the environment.

Furthermore, once the instrument is assembled, the process continued with the validation stage of the environmental ethics instrument. Assessment was carried out by experts and practitioners (lecturers) by giving a check mark (√) to the column corresponding to the aspects to be assessed, consisting of the content feasibility, construction, and language aspects. The interpretation was that if the agreement index was less than 0.4, the validity was low; if the agreement index

was between 0.4-0.8, the validity was moderate, and if it was more than 0.8, the validity was high (Retnawati, 2016). The results of the validation of the environmental ethics observation sheet are shown in Table 5.

Table 5
Validation of the developed observation sheet for environmental ethics

Test Items		Assessors						Σs	V ($\Sigma s/[n(c-1)]$)	Summary
		E1	E2	E3	E4	E5	E6			
1	Score (r)	5	5	4	5	4	5	22	0,917	High Validity
	S	4	4	3	4	3	4			
2	Score (r)	5	4	4	4	4	5	20	0,833	High Validity
	S	4	3	3	3	3	4			
3	Score (r)	3	4	3	4	4	5	17	0,708	Moderate Validity
	S	2	3	2	3	3	4			
4	Score (r)	5	5	4	5	4	4	21	0,875	High Validity
	S	4	4	3	4	3	3			
5	Score (r)	5	3	3	4	4	5	18	0,750	Moderate Validity
	S	4	2	2	3	3	4			
6	Score (r)	5	3	4	4	4	4	18	0,750	Moderate Validity
	S	4	2	3	3	3	3			
7	Score (r)	5	5	4	4	4	3	19	0,792	Moderate Validity
	S	4	4	3	3	3	2			
8	Score (r)	5	5	4	5	4	4	21	0,875	High Validity
	S	4	4	3	4	3	3			
9	Score (r)	3	3	3	4	4	5	16	0,667	Moderate Validity
	S	2	2	2	3	3	4			
10	Score (r)	3	3	3	4	4	4	15	0,625	Moderate Validity
	S	2	2	2	3	3	3			
11	Score (r)	5	4	4	4	4	4	19	0,792	Moderate Validity
	S	4	3	3	3	3	3			
12	Score (r)	5	5	4	5	4	5	22	0,917	High Validity
	S	4	4	3	4	3	4			
13	Score (r)	4	4	4	4	4	4	18	0,750	Moderate Validity
	S	3	3	3	3	3	3			
14	Score (r)	5	5	4	5	4	5	22	0,917	High Validity
	S	4	4	3	4	3	4			
15	Score (r)	4	4	4	4	4	4	18	0,750	Moderate Validity
	S	3	3	3	3	3	3			
Final Result									0,794	Moderate Validity

Description: E = Expert; L = Lecturer

Based on the coefficient analysis of the content validity (Aiken's V), it can be concluded that the observation sheet containing 15 questions related to environmental ethics was valid and feasible to use as environmental ethics instrument, with Aiken's V value of 0.794 with the medium validity category. After conducting the validation by experts and practitioners, the reliability test was conducted to measure the level of understanding among the assessors toward the

instrument developed by using inter-rater reliability, which is presented as follows (Table 6).

Table 6
Statistics of reliability environmental ethics assessment

Cronbach's Alpha	N of Items
0,883	6

Based on Cronbach's Alpha reliability value of $0.883 > 0.60$, it can be stated that all question items in the observation instrument for environmental ethics are reliable and consistent. Furthermore, based on the Intraclass Correlation Coefficient value of 0.883, it can be said that reliability between experts is satisfactory (Table 7).

Table 7
Intraclass correlation coefficient environmental ethics assessment

	Intraclass Correlation ^b	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	0.558 ^a	0,406	0,715	8,564	29	145	0,000
Average Measures	0.883 ^c	0,804	0,938	8,564	29	145	0,000

Thus, after going through various stages in the development of instruments starting from the planning and drafting stage of the instrument, the instrument validation and trial, the revision and final preparation stages of the instrument, the final results of experts' and practitioners' validation show that the instrument for environmental literacy and environmental ethics assessment has met the valid and reliable category so that it is ready to be used in taking research data. The test instruments developed can then be used for data collection related to environmental literacy, and non-test instruments can be used to retrieve data related to environmental ethics. Environmental literacy test instruments are declared valid and reliable, and all items (22 items) can be used, with a very high reliability test ($r\text{-Speman} = 0.950$). Meanwhile, the environmental ethics instrument is stated to have moderate validity with Aiken index of 0.794, and Cronbach's Alpha reliability value of 0.883, so that it is feasible to use for data retrieval.

Discussion

The results of product development in this study are a set of environmental literacy and environmental ethics assessment instruments, were generated by using the (Oreondo & Antonio, 1984). The formulation of environmental literacy and ethics instruments is carried out as part of the evaluation process that aim to improve student literacy and environmental ethics. According to (Lwo et al., 2017) teachers should be concerned with environmental issues and discuss environmental topics in their classrooms, indicating a high percentage (89.6%

and 85.0%, respectively). Many research results (Goulgouti et al., 2019; Sadik & Sadik, 2014; Tuncer et al., 2007) reveal the importance of increasing environmental literacy. Overall, teachers were found to be more concerned about environmental ethics, and believed that educating people about environmental ethics was a long process. This research provides several implications for scholars who are concerned with the environment and ethics.

The assessment grid is prepared by determining aspects and indicators of environmental literacy abilities that are in accordance with the material in ecology lectures. Based on the results of the FGD, the environmental literacy competencies to be achieved in this study are (1) knowledge component (cognitive): knowledge of the physical and ecological systems and knowledge of environmental issues, (2) affective components: environmental sensitivity and attitudes towards the environment, (3) competence component (cognitive skills): identifying environmental issues, analyzing environmental issues, making plans for investigating environmental issues, and (4) responsibility behavior components (Chu et al., 2007; Hollweg et al., 2011; Nasution, 2016). Currently, environmental damage has occurred, therefore through the educational process it is necessary to develop students' environmental literacy in order to overcome environmental damage (Alvarez-García et al., 2018; Dolenc Orbanić & Kovač, 2021). According to (Kaya & Elster, 2019; Keinonen et al., 2016) environmental literacy is the main effective capital for environmental conservation. The characteristics of environmental literacy are increased awareness, attitudes, values, and knowledge of the environment, as well as being able to work together responsibly to protect the environment (Aminrad et al., 2013; Ardoin et al., 2020). Based on those content outline and indicators, 20 test items were devised. The multiple-choice test was chosen because this test can measure various stages of ability, both understanding, affective components, cognitive skills, and responsibility behavior. In addition, this form of test also provides convenience when conducting an assessment, with minimal time, so that the scoring results can be immediately known.

The characteristics of the environmental literacy test instrument had the level of difficulty of 0.515, which means that the level of difficulty of the questions was in the medium category. Test items are considered ideal, if they are not too easy and not too difficult (Stiggins, 1994; Turney & Thomas, 1972). Thus, based on the assessment of the difficulty index, it is known that the items compiled have met the ideal criteria. Meanwhile, the item discrimination was 0.348, which means that the problem had a item discrimination index in sufficient categories. Based on discriminatory analysis, if the result is negative, the item cannot be used and must be discarded (Stiggins, 1994; Turney & Thomas, 1972). The categories obtained from each test item are "enough" and "good", and are not negative, so all test items can be used.

Moreover, the instrument test reliability was very high with the value of 0.950. Based on the analysis, it can be concluded that the test instrument containing 22 items related to environmental literacy was valid and feasible to use. Validity and reliability of test items are considered important because these will determine the quality of the research data that has been collected and at the same time avoid the occurrence of data errors because the valid and reliable instrument has been

declared ready and feasible to use (Banerjee et al., 2014; Md Ghazali, 2016; Yalcin & Yalcin, 2017; Yanto et al., 2019). Similar to the environmental literacy instrument, the assessment grid is prepared by determining aspects and indicators of environmental ethics abilities that are in accordance with the material in ecology lectures. Based on the results of the FGD, the instrument was constructed based on the Principles of Environmental Ethics (Keraf, 2010), which only covered five principles including respect for nature, responsibility principles, No Harm Principles, compassion for and concern with nature principles, and cosmic solidarity principles. Based on this, the importance of environmental literacy and ethical instruments in understanding various environmental crises and raising awareness about environmental issues is also supported by several studies (Alagoz & Akman, 2016; Carmi & Alkaher, 2019; Ergin, 2019). Students must have awareness about environmental literacy and ethics to solve problems (Metin et al., 2011).

4 Conclusion

Environmental literacy instruments were constructed based on four things, namely knowledge competencies (cognitive), affective competencies, cognitive skill competencies, and responsibility behavior competencies. With the characteristics seen in the level of difficulty with the value of 0.515, the difficulty level of the questions is in the medium category. Meanwhile, based on the item discrimination index of 0.348, it is considered being sufficient. Observation instruments for Environmental ethics were constructed based on environmental ethical principles, which consisted of respect for nature, responsibility principles, No Harm principles, compassion and concern for nature principles, and cosmic solidarity principles. Based on the validity test results by experts and practitioners on each instrument item that had been developed, both environmental literacy instruments and environmental ethics instruments show that all instrument items meet the requirements to be used as instruments for measuring and evaluating students' activity during the learning process. Implications for further research is needed to develop and test the environmental ethics and literacy instruments through the implementation of other levels of education in order to obtain more feasible and valid instruments to improve environmental literacy and ethics. In addition, the development of environmental literacy and ethics instruments can be carried out by other researchers in accordance with needs, especially for material that has not been contained in the instruments we have developed. It can also be undertaken by increasing the number of items (questions) based on existing indicators so that they can improve accuracy of assessment.

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