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Developing and Validating an Instrument for Measuring Pre-Service Science Teachers' Environmental Knowledge

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ABSTRACT

Environmental literacy assessment of pre-service science teacher candidates is no patent, so there is a need to develop special instruments for science teacher candidates that are by the character of the subject to be studied. This study aimed to develop a valid and reliable instrument to be used for measuring science teacher candidates' environmental knowledge of environmental literacy. This instrument was validated by two experts and wide pilot testing involves 31 science teacher candidates from biology teacher candidates, physics teacher candidates, and chemistry teacher candidates. Results of content validation in this study, show that experts suggested revising five questions. Results of criteria validation in this study using the Cronbach Alpha test show that only seven of 15 questions can be used to assess the environmental knowledge of science teacher candidates. One question item was received without correction and six other questions were received with revision. The reliability of the instrument was measured using the Kuder Richardson 20 (KR 20) test and the result was 0.63, which means the instrument was acceptable for use. The results of this study indicate that the instrument is valid and reliable for the assessment of a science teacher candidate's environmental knowledge. However, this instrument still has to be tested again if it is to be used to measure the validity and reliability of the instrument before being used to measure other data.

Keywords: Environmental education, Environmental literacy, Pre-service science teacher

Introduction

Humans in their lives are currently experiencing various environmental problems: forest destruction, water, soil, and air pollution (KLHK, 2019); global climate change (Meiviana et al., 2004); ozone layer depletion (Grey, 2020), biodiversity extinction (IUCN, 2020). Even from these data, this environmental problem is getting worse every day. These damages show that environmental management in Indonesia has not been maximized. The utilization of the environment has not been balanced with its conservation.

The understanding and attitude of concern for environmental sustainability is very necessary to be instilled in the younger generation as the next inheritor of responsibility. Through environmental education, the younger generation is expected to be able to maintain, manage, and preserve the environment wisely and wisely so that an environmentally literate generation will be created. Because according to Köse et al. (2011), only individuals who have literacy, awareness, and sensitivity will contribute to dealing with environmental problems.

The global definition of environmental literacy has not been explicitly defined (Goldman et al., 2014). However, several studies have revealed some of the components that make up environmental literacy. One of the components of environmental literacy is environmental knowledge (Naaee, 2011; Teksoz et al., 2012; Timur et al., 2013).

Environmental literacy in the form of environmental knowledge can be evaluated in prospective teachers (Shephard et al., 2014) who will be the forerunner of teachers who carry out a vital role in education. However, there is still no patent environmental literacy assessment instrument for prospective science teachers, so there is still a need to develop a special instrument for science teachers that suits the character of the subject to be studied.

Methods

This instrument development stage adapts from (Kyngäs et al., 2020) with three main stages. The first stage, the Conceptual Framework Development and Item Generation stage, the second stage is called the Judgment Quantification stage, and the last stage is called the Psychometrics Testing for Instrument stage.

1. **Conceptual Framework Development and Item Generation**
   At the Conceptual framework development and Item Generation stage, the dimensions of the research variables are analyzed to be reduced to indicators which will later be reduced back to question items. The development of this instrument is part of the research on Environmental Literacy which in this case the researcher will only focus on discussing the Environmental Knowledge dimension. Of the many materials related to the environment, researchers decided to develop indicators of environmental knowledge from the materials of global climate change, pollution, and energy conservation. For each material, 5 items were prepared as pool items. So, the total number of items compiled is 15 items.
2. **Judgment Quantification**
   The next stage is the Judgment Quantification stage. At this stage, the researcher chose an expert validator to assess the suitability of the question items with the material and dimensions that had been developed by the researcher. In addition, researchers also asked for opinions about the language used in each question item. The results of the assessment are descriptive. This expert assessment is also known as the construct and content validation stage.
3. **Psychometrics Testing for Instrument**
   After going through the Judgment Quantification stage, the next stage is the Psychometric Testing for the Instrument stage which is the last stage of developing this instrument. At this stage, the instrument is tested to measure its validity and reliability.

Results and Discussion

1. Conceptual Framework Development and Item Generation

In this study, researchers only used one dimension of environmental literacy, namely the environmental knowledge dimension. The materials chosen from the many materials about the environment are about global climate change, pollution, and also energy conservation. From each material, it is derived into five indicators which are later reduced back into five questions. Each indicator is reduced to one question. Questions for environmental knowledge assessment are in the form of true statements and false statements. The score of each question is the same, namely one for the correct answer and zero for the wrong answer. The lattice of environmental knowledge assessment instrument items is presented in Table 1.

Table 1. Item lattice of environmental knowledge assessment instrument for prospective science teacher students

Environmental Literacy Dimensions	Environmental Materials	Indicator	Type of Statement	Statement Item
Environmental Knowledge	**Global Climate Change**	Understand the function of greenhouse gases and their effects on life on Earth	False	The greenhouse effect has always harmed the Earth's ecosystems
			False	Global warming is caused by the construction of many glass buildings
		Understand the causes of global climate change	False	Global climate change causes global warming
			True	Greenhouse gases cause global warming
		Understand efforts to reduce the causes of global climate change	True	CO_2 reduction can only be done by plants with photosynthesis
	Pollution	Understand the sources and causes of air pollution	True	Household waste produces air pollutants in the form of methane gas (CH_4)
			True	Saving electricity can reduce air pollution
		Understand how to reduce air pollution	False	The atmosphere is so vast that it can neutralize exhaust gases from human activities in the lithosphere
		Understand the sources and causes of water pollution	False	Alkyl Benzene Sulfonate (ABS) content in detergents can cause eutrophication
		Understand the distribution of water on earth	True	Of all the water on earth, only a small amount can be consumed directly by living things.
	Energy Conservation	Understand the energy resources	False	Energy is an unlimited resource

Environmental Literacy Dimensions	Environmental Materials	Indicator	Type of Statement	Statement Item
		Understand efforts to conserve electrical energy	True	Cell phone chargers that are connected to the electricity even when not in use still suck up electrical energy
			False	Low-wattage lights are always dimmer
		Understanding energy conservation efforts	True	Energy conservation is not only saving energy but also using renewable energy.
			True	Technological developments affect the success of energy conservation efforts

2. Judgment Quantification

The results of the expert assessment, some items were asked to change the editorial sentence so as not to cause ambiguity. Then some questions are also asked to choose material content that is more common and more familiar to students because the subjects to be studied later are prospective science teachers who do not all majors discuss details related to environmental issues (Table 2).

Table 2. Valid and reliable environmental literacy assessment instrument for science teacher candidates

Statement Item	Validity	The Meaning of Validity	Revised Statement Item	Reliability
CO_2 reduction can only be done by plants with photosynthesis	0.263	Revision	CO2 reduction can only be done by plants through photosynthesis	**0.63**
Household waste produces air pollutants in the form of methane gas (CH_4)	0.341	Valid	-	
Alkyl Benzene Sulfonate (ABS) content in detergents can cause eutrophication Alkyl Benzene Sulfonate (ABS) content in detergents can cause eutrophication	0.061	Revision	Alkyl Benzene Sulfonate (ABS) content in detergents can cause an explosion in the number of aquatic plants due to the abundant availability of nutrients in the water	
Saving electricity can reduce air pollution	0.138	Revision	Saving electricity can indirectly reduce air pollution	
Of all the water on earth, only a small amount can be consumed directly by living things	0.370	Valid	-	
Cell phone chargers that are connected to the	0.248	Revision	Charger HP includes "energy vampires" even	

Statement Item	Validity	The Meaning of Validity	Revised Statement Item	Reliability
electricity even when not in use still suck up electrical energy			though it is not used. but still plugged into the power source. still suck electricity energy	
Energy conservation is not only saving energy but also using renewable energy	0.071	Revision	Energy conservation activities not only save energy but also use new renewable energy such as the use of solar energy	

3. Psychometrics Testing for Instrument

Because the question items only have one correct answer and the difficulty level of the questions is considered the same. The calculation of instrument reliability uses the Kuder Richardson 21 (KR 21) internal consistency test reliability testing technique (Yusup, 2017). The results of KR 21 testing. The environmental knowledge assessment instrument for prospective science teachers is 0.63. This means that this instrument is reliable for capturing data on environmental knowledge possessed by prospective science teachers (Table 2).

In Table 2 statements with validity values below 0.301 (N=31 and one-sided r) are declared valid but need revision. Five statements need to be revised and only 2 are valid without revision. The reliability value of the instrument for assessing environmental literacy in the dimension of environmental knowledge for prospective teacher students is 0.63. This value according to Mudanta et al. (2020) includes high reliability to explore data on environmental literacy in the knowledge dimension for prospective science teacher material

Conclusion

Based on content and construct validation to experts. as well as based on criterion validation using Cronbach's Alpha test. The instrument consisting of seven items was declared feasible. After being tested using the KR 20 test, the reliability value reached 0.63 which means that this instrument is reliable for collecting data on the environmental knowledge of prospective science teachers. This instrument is declared valid and reliable to assess the environmental knowledge of prospective science teacher students. Because the validity and reliability of an instrument are also determined by the subject being measured. This instrument must still be tested again before being used on other research subjects.

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References

Goldman, D., Yavetz, B., & Pe'er, S. (2014). Student teachers' attainment of environmental literacy in relation to their disciplinary major during undergraduate studies. *International Journal of Environmental and Science Education*, *9*(4), 369–383. https://doi.org/10.12973/ijese.2014.222a

Grey, E. (2020). nasa.gov. Retrieved August 11, 2020, from nasa: https://www.nasa.gov/feature/goddard/2020/nasa-reports-arctic-stratospheric-ozone-depletion-hit-record-low-in-march

IUCN. (2020). IUCN Red List. Retrieved August 11, 2020, from iucnredlist.org: https://www.iucnredlist.org/

KLHK. (2019). *Indeks Kualitas Lingkungan Hidup Indonesia 2018*. Jakarta: Kementerian Lingkungan Hidup dan Kehutanan.

Köse, S., Savran Gencer, A., Gezer, K., Erol, G. H., & Bilen, K. (2011). Investigation of Undergraduate Students' Environmental Attitudes. *International Electronic Journal of Environmental Education*, *1*(2), 85–96.

Kyngäs, H., Mikkonen, K., & Kääriäinen, M. (2020). *The Application of Content Analysisin Nursing Science Research*. Cham: Springer.

Meiviana, A., Sulistiowati, D. R., & Soejachmoen, M. H. (2004). *Bumi Makin Panas: Ancaman Perubahan Iklim di Indonesia*. Jakarta: Pelangi.

Mudanta, K. A., Astawan, I. G., & Jayanta, I. N. L. (2020). Instrumen Penilaian Motivasi Belajar dan Hasil Belajar IPA Siswa Kelas V Sekolah Dasar. *Mimbar Ilmu*, *25*(2), 101. https://doi.org/10.23887/mi.v25i2.26611

Naaee, N. (2011). *Developing a framework for assesing environmental literacy*.

Shephard, K., Harraway, J., Lovelock, B., Skeaff, S., Slooten, L., Strack, M., … Jowett, T. (2014). Is the environmental literacy of university students measurable? *Environmental Education Research*, *20*(4), 476–495. https://doi.org/10.1080/13504622.2013.816268

Teksoz, G., Sahin, E., & Tekkaya-Oztekin, C. (2012). Modeling Environmental Literacy of University Students. *Journal of Science Education and Technology*, *21*(1), 157–166. https://doi.org/10.1007/s10956-011-9294-3

Timur, S., Timur, B., & Yilmaz, S. (2013). Determining primary school candidate teachers' levels of environmental literacy. *Anthropologist*, *16*(1–2), 57–67. https://doi.org/10.1080/09720073.2013.11891335

Yusup, F. (2017). Validity and Reliability Test of Quantitative Research Instruments. *Jorpres (Jurnal Olahraga Prestasi)*, *13*(1), 53–59. https://doi.org/10.21831/jorpres.v13i1.12884