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DEVELOPMENT OF ENVIRONMENTAL SENSITIVITY INSTRUMENTS (ESI) BASED ON GREEN CHEMISTRY PRINCIPLES (GCP) FOR CHEMISTRY LEARNING IN HIGH SCHOOLS

[a] Jusniar Jusniar, [b] Syamsidah Syamsidah, [c]Army Auliah

ABSTRACT

Objective: The developing environmental sensitivity instruments oriented towards the Green Chemistry Principles (GCP). GCP-oriented environmental sensitivity instrument products feasible in terms of validity and reliability.

Theoretical framework: International scientific reports, articles, and publications served as the basis for the theoretical contents. Additionally, produce an instrument on environmental sensitivity that is valid and reliable.

Method: Research on the development of instruments for environmental sensitivity was designed in three stages. First stage; design and development of environmental sensitivity grids and instruments based on aspects that have been studied theoretically. Second Stage; content validity testing. Third Stage; Construct Validity Testing and Instrument Reliability. This environmental sensitivity instrument was developed from four aspects, namely Harmony and diversity, environmental balance, interdependence, and sustainability. The indicators of these four aspects are related to the principles of green chemistry (GCP) which can be implemented in chemistry learning. Testing the validity of the content validity ratio (CVR) and Exploratory Factor Analysis (EFA) techniques.

Results and Conclusion: Reliability testing with the Cronbach's Alpha technique shows that the instrument has a consistency of 0.792 (high). The results of testing the content validity using the CVR technique by eight experts obtained 24 items including in good validity category and one item in valid. The results of the EFA test conducted on 116 high school students in South Sulawesi, Indonesia showed that the sample met the adequacy of the test with the KMO and Barlett's tests. EFA analysis shows that the anti-image correlation of 24 indicators is greater than 0.5 with communality not deviating from the factor analysis, meaning that there is a consistent relationship between the indicators in the four aspects studied. Thus, the GCP-oriented environmental sensitivity instrument is declared valid and reliable to use.

Originality/value: The results showed that the instrument for assessing environmental sensitivity in GCP-oriented chemistry learning was declared valid and reliable because it met all the criteria of content validity with CVR, construction validity with EFA, and high instrument reliability. The findings of this study add to knowledge and information about assessment in the realm of environmental sensitivity which of course greatly contributes to learning. There are so many phenomena of environmental damage that need to be addressed around us and

[a]Professor of Chemistry in Faculty of Mathematics and Science, Universitas Negeri Makassar, South Sulawesi, Indonesia, E-mail: jusniar@unm.ac.id, Orcid: https://orcid.org/0000-0003-3403-5538
[b]Doctor of Family Welfare Education, Faculty of Engineering, Universitas Negeri Makassar, South Sulawesi, Indonesia, E-mail: syamsidah@unm.ac.id, Orcid: https://orcid.org/0000-0003-3245-7024
[c]Doctor of Chemistry in Faculty of Mathematics and Science, Universitas Negeri Makassar, South Sulawesi, Indonesia, E-mail: auliaarmy@ymail.com, Orcid: https://orcid.org/0000-0002-2756-6093

that requires a sense of care and sensitivity from teachers, students and the community. Chemistry teachers or other researchers can use this instrument to find out attitudes in the form of students' sensitivity to GCP-oriented environments.

Keywords: environmental sensitivity instrument, green chemistry principle, chemistry learning.

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DESENVOLVIMENTO DE INSTRUMENTOS DE SENSIBILIDADE AMBIENTAL (ESI) BASEADOS EM PRINCÍPIOS DE QUÍMICA VERDE (GCP) PARA A APRENDIZAGEM DE QUÍMICA EM ESCOLAS DE ENSINO MÉDIO

RESUMO

Objetivo: O desenvolvimento de instrumentos de sensibilidade ambiental orientados para os Princípios de Química Verde (PCG). Produtos de instrumentos de sensibilidade ambiental orientados para GCP viáveis em termos de validade e confiabilidade.

Estrutura teórica: Relatórios científicos internacionais, artigos e publicações serviram de base para os conteúdos teóricos. Além disso, produzir um instrumento de sensibilidade ambiental que seja válido e confiável.

Método: A pesquisa sobre o desenvolvimento de instrumentos de sensibilidade ambiental foi projetada em três fases. Primeiro estágio; projeto e desenvolvimento de redes de sensibilidade ambiental e instrumentos baseados em aspectos que foram estudados teoricamente. Segundo estágio; teste de validade do conteúdo. Terceira Fase; Construir Teste de Validade e Confiabilidade do Instrumento. Este instrumento de sensibilidade ambiental foi desenvolvido a partir de quatro aspectos, nomeadamente Harmonia e diversidade, equilíbrio ambiental, interdependência e sustentabilidade. Os indicadores destes quatro aspectos estão relacionados com os princípios da química verde (GCP) que podem ser implementados na aprendizagem de química. Testar a validade das técnicas de razão de validade do conteúdo (CVR) e análise exploratória do fator (AFE).

Resultados e Conclusão: O teste de confiabilidade com a técnica Alpha de Cronbach mostra que o instrumento tem uma consistência de 0,792 (alta). Os resultados do teste da validade do conteúdo usando a técnica de CVR por oito especialistas obtiveram 24 itens, incluindo na categoria de boa validade e um item em válido. Os resultados do teste da AFE realizado em 116 estudantes do ensino médio em Sulawesi do Sul, na Indonésia, mostraram que a amostra atendeu à adequação do teste com os testes da KMO e Barlett. A análise da AFE mostra que a correlação anti-imagem de 24 indicadores é maior que 0,5 com comunitariedade não se desviando da análise fatorial, o que significa que há uma relação consistente entre os indicadores nos quatro aspectos estudados. Assim, o instrumento de sensibilidade ambiental orientado para GCP é declarado válido e confiável de usar.

Originalidade/valor: Os resultados mostraram que o instrumento para avaliar a sensibilidade ambiental na aprendizagem de química orientada para GCP foi declarado válido e confiável porque atendia a todos os critérios de validade de conteúdo com CVR, validade de construção com AFE e alta confiabilidade do instrumento. As conclusões deste estudo contribuem para o conhecimento e a informação sobre a avaliação no domínio da sensibilidade ambiental, o que, naturalmente, contribui muito para a aprendizagem. Há tantos fenômenos de danos ambientais que precisam ser abordados ao nosso redor e que requerem um senso de cuidado e sensibilidade de professores, estudantes e da comunidade. Os professores de química ou outros pesquisadores

podem usar esse instrumento para descobrir atitudes na forma de sensibilidade dos alunos a ambientes orientados para GCP.

Palavras-chave: instrumento de sensibilidade ambiental, princípio de química verde, aprendizagem de química.

1 INTRODUCTION

Attitude is one aspect of assessment in learning, in addition to cognitive and psychomotor. These three aspects of the assessment are interrelated and have their respective contributions. Based on the curriculum study, attitudes are classified into two parts, namely spiritual attitudes and social attitudes. Attitude is part of the object of assessment of a person's mind, ranging from something very ordinary to something abstract, either in the form of ideas from individuals or groups (Bohner & Dickel, 2011). Attitude or character is important, because it is results from experiences that are formed over time, thus shaping people's perceptions of the social and physical world. In the end, giving and receiving behavior will be formed (Sharma & Srivastav, 2021). This sensitivity includes characters or attitudes that need to be accustomed to so that they become a culture or habit (Roosevelt, 2008).

Strengthening student's character is an emphasis on implementing the Independent Curriculum in Indonesia with new nuances that giving freedom of thought (Kusumastuti, et al., 2021). This curriculum also encourages students and teachers to be able to change their learning paradigm from traditional to contemporary (Telaumbanua et al., 2022). The Indonesian government carries the idea of "Freedom" as an effort to achieve independence in students to be creative, critical, and collaborative (Yulianto et al., 2021). In addition, it introduces issues of sustainability, local wisdom, ideology, Indonesian spirit, democracy, technological innovation, and entrepreneurship (Tjaija, 2022). The independent curriculum in its implementation focuses more on character development and student competence. Character development is the main aspect of the Pancasila student profile that needs to be developed in educational units. In fact, the three aspects as educational products, namely knowledge (concepts), attitudes (feelings), and behavior are interconnected (Damasio, 1999; Le Doux 1998) and mutually support one another. The formation of attitudes and beliefs plays a role in building a value system that supports relationships with the environment (Brody 2005). Thus, it is very urgent to develop instruments that are oriented towards measuring attitudes, especially related to attitudes towards the environment (Pe'er et al., 2007; Lake, 2010)

The knowledge given about the environment is expected to raise awareness to learn to be responsible and have a positive attitude towards the environment (Morgil, et al., 2004). This awareness will raise students' sensitivity to the surrounding environment. Environmental sensitivity is actually not an innate talent or instinct, but rather the result of an educational process. This sensitivity is one of the six aspects of environmental literacy (Roth, 1992). Another term by Orr (1992) is referred to as ecological literacy with an emphasis on education for sustainability (EFS). Sensitivity to the environment is a feeling that a person has to improve and manage the environment properly and usefully, so that it can be enjoyed continuously without damaging its condition. Besides that, it helps protect and preserve the environment so that there are sustainable and sustainable benefits (Ministry of National Education, 2010). The concept of environmental sensitivity is based on the level of sensitivity, specifically having a meaning about deep ecology or into ecological understanding, in this case it is more oriented towards the principles of green chemistry (GCP).

Environmental awareness trains students' sensitivity in the form of attitudes, behaviors, and willingness to act on environmental problems. The need for environmental education and awareness is very important, because it is an important step to reduce environmental damage caused by various activities. Researchers have shown that environmental education is necessary (Chen et al., 2020; Flanagan et al., 2019; Moseley et al., 2019; Woosnam et al., 2018) to maintain environmental awareness. In 2019, research conducted by Flanagan et al. (2019) showed that environmental education can increase people's environmental awareness. Therefore, it is hoped that it can open new horizons for future teacher candidates regarding environmental awareness, with green chemistry-oriented learning so that environmental awareness increases.

Many researches of development and usage of instruments on affective aspects have been carried out, such as the development of attitude assessment instruments for socio scientific issues (SSI) in the chemistry field (Suparman, et.al (2022); SSI in the Biology sector (Subiantoro and Treagust, 2020); Literacy environment (Teksöz et al., 2010); (Tuncer, et al., 2014); ecological literacy (Cutter-Mackenzie & Smith, 2003); environmental awareness (Flanagan, et al., 2019); Morgil, et al. (2004). So far, no one has reported on the development of instruments on GC-oriented environmental sensitivity.

2 RESEARCH PURPOSES

1. What is the process for developing environmental sensitivity instruments oriented towards the Green Chemistry Principles (GCP)?

2. Are GCP-oriented environmental sensitivity instrument products feasible in terms of validity and reliability?

3 REVIEW LITERATURE

3.1 ENVIRONMENTAL SENSITIVITY AND EDUCATION FOR SUSTAINABILITY (EFS)

In recent decades, environmental problems have become a global concern such as ozone depletion, deforestation, loss of biodiversity and climate change. The causes are complex and the solutions are complex (Dunlap, et al, 2000). Researchers who are interested in understanding how society perceives environmental problems are more likely to focus on the "attitude" aspect. Of course, this aspect has the potential to be related to the educational process, especially in relation to the issue of sustainable development. Education for Sustainable Development (ESD) has also been widely studied (Andersson et al., 2013; Kioupi & Voulvoulis, 2019). With regard to environmental care attitudes, it is important to educate students about values related to sustainability and relevant interests in the education system to provide ESD (Sánchez et al., 2022). To meet the needs of the present generation while saving for future generations (Abeyrathna, 2021). Actions to save the environment can be done early on through education. This supports the achievement of sustainable development targets with relevant green chemistry principles in learning (Wardencki et al., 2005). Research on instilling ESD and SDGs values in the curriculum has been carried out by (Zguir et al., 2021); SDGs with an independent curriculum in Indonesia (Purnomo et al., 2023); Studies on the relationship between quality education and ESD and learning with sustainability have also been conducted (Didham & Ofei-Manu, 2020). There are two environmental pillars that contribute to involving sustainable chemistry through the process of chemistry education and learning (Evans et al., 2017). The twelfth and thirteenth goals are related to responsible consumption and production and climate change action, respectively.

Green Chemistry (GC) is a philosophy that drives processes by reducing or eliminating the use and production of hazardous substances (Anastas & Zimmerman,

2018). There are twelve Green Chemistry Principles, namely: 1. Preventing waste; 2. Maximizes atomic economy 3. Designs safe chemicals and chemical products; 4. Designing less dangerous chemical synthesis; 5. Use safe solvents and reaction conditions; 6. Improve energy efficiency; 7. Using renewable raw materials; 8. Avoid chemical derivatives: 9. Use catalysts instead of stoichiometric reagents: 10. Design chemicals and products that decompose after use:11. Real-time analysis to prevent pollution: 12. Minimizing the potential for accidents (Manahan, 2006; Anastas & Warner, 1998). The principles of GC can be adapted to be applied in human attitudes and actions as an effort to save the environment which is realized through education or green education. This effort requires seriousness in education through instilling awareness of the importance of sensitivity to the environment as a way of seeing oneself in relation to nature (Morgil, et al, 2004). Several studies have shown that a rich human ecological sensory experience is directly related to increased creativity, awareness, health, ecological awareness and environmental sensitivity (Chiarotto, 2011; Kellert, 2002); Louv, 2012).

3.2 THE IMPORTANCE OF DEVELOPING ENVIRONMENTAL SENSITIVITY INSTRUMENTS

Environmental problems are an integral part of our lives. Everyone instinctively fulfils his life needs that come from resources. A maintained or sustainable environment will improve the quality of human life (Rohawatiningsih et al., 2018). Excessive use of nature without considering the bad effects, can cause environmental damage which of course will be detrimental to humans themselves. Thus, it is important to have awareness and sensitivity for the use of the surrounding environment so that there is balance and harmony of life established through the educational process. Many researchers argue that to generate a sense of responsibility for the environment it is necessary to create positive actions towards environmental preservation (Sia, Hungerford, & Tomera, 1985; Sivek & Hungerford, 1989). Research has identified that attitudes, locus of control (LOC), knowledge, responsibility, social norms, sexual roles, sensitivity, and intention to act are related to creating responsible environmental behaviors (Boerschig & DeYoung, 1993; Hines, Hungerford, & Tomera, 1986; Hungerford & Volk, 1990; Sia et al., 1985). Moreover, they argue that changing these affective and cognitive factors to be more

environmentally friendly will result in more responsible environmental behavior (Thi, P., & Thoan, P., 2023)

The learning environment represents the shared psychosocial perceptions between students and their environment, including teachers in the same environment (Fraser 2001). Consequently, the instrument of students' perceptions of the learning environment is an appropriate tool for exploring specific goals including environmental sensitivity (Fraser 2012) related to science learning (Aldridge et al. 1999). Research using various learning environment instruments has been used to elicit students' perceptions of their ideal choice of science classroom environment (Fraser 2012) such as the Learning Environment Inventory (LEI), developed by Walberg and Anderson (1968); Environmental awareness instrument by Morgil, et al. (2004); Littledyke, (2008); (Flanagan, 2019); Environmental literacy (Teksöz et al., 2010); (Tuncer, et al., 2014); Ecological literacy (Cutter-Mackenzie & Smith, 2003).

4 MATERIALS AND METHOD

4.1 RESEARCH DESIGN

Research on the development of instruments for environmental sensitivity was designed in three stages. These stages are described as follows:

First stage; design and development of environmental sensitivity grids and instruments based on aspects that have been studied theoretically. This aspect of the study focuses more on students' social attitudes which can be revealed in relation to the 12 principles of green chemistry (GCP). The grid is developed based on the four aspects of environmental sensitivity studied; 1) Harmony of life and diversity; 2) Environmental Balance; 3) interdependence; 4) Sustainable (SGDs). (Dunlap, et al., 2000). Of the twelve GC Principles put forward by (Anasstas & Warner, 1998) there are three principles that can be linked to this questionnaire, namely: (1) prevent waste (GCP 1); (2) Increased energy efficiency (GCP 6); `(3) Minimize the potential for accidents (GCP 12). The GCP-oriented environmental sensitivity grid was produced as a product of this development. The data analysis used is the study and description of secondary sources to develop the grid and its instruments. Based on this grid, a questionnaire was developed in the form of statements of social attitudes associated with GCP. This questionnaire contains statements as a description of the dimensions of environmental sensitivity that are related to GCP. This statement contains two attitudes namely positive and negative.

Second Stage; content validity testing; Content validity was carried out by the Expert by adjusting the instrument grids with the points of the environmental sensitivity attitude statement. Data sources at this stage were eight experts as panellists. Content validity testing is done by content validity ratio (CVR). The score is declared essential if the score is three or four, declared non-essential if the expert score is one or two.

Third Stage; Construct Validity Testing and Instrument Reliability

Construct validity testing was carried out on 116 students (89 girls and 27 boys) in class X SMAN 1 Gowa, South Sulawesi. The questionnaire is given in the form of a google form. The results of this test are also used to determine the reliability of the instrument with the Cronbach alpha technique**.**

4.2 SAMPLES AND DATA COLLECTION TECHNIQUES

In testing the content validity using the CVR technique, eight experts were involved as panellists. The experts consist of three chemistry education experts, two environmental chemists, and three education practitioners (Chemistry Teachers). In the construct validity testing stage, the samples involved were 116 students (89 girls and 27 boys) of class X SMAN 1 Gowa, South Sulawesi. The validated environmental sensitivity questionnaire consisted of 25 items which were given in the form of a Google form to the respondents. The questionnaire contains statements which are the elaboration of the four dimensions of environmental sensitivity. The attitude scale was modified from a five-choice Likert scale to four scales, namely strongly disagree (SDA), disagree DA, agree (A), and strongly agree (SA).

4.3 DATA ANALYSIS

The process of developing instruments for environmental sensitivity is based on literature studies and research results. The results of this secondary source study were obtained by environmental sensitivity grids and instruments. The grid contains four aspects of environmental sensitivity which are translated into twenty-five items. The grids and instruments were then content validated to eight experts using the content validity ratio (CVR) technique. Research with eight experts as panellists obtained a minimum approach of 0.75 (Lawse, 1975). This means that the item criteria are said to have good validity if the CVR price is greater than or equal to 0.75. The CVR price is obtained by comparing the total difference in the number of essential and non-essential items/or not

filled in with the total panellists. The value of CVR which is greater or equal to 0.50 is categorized as having good validity; and if it is less than 0.50 it is declared invalid. Factor analysis in this study used the exploratory factor analysis (EFA) method. EFA can be directly applied to instrument development (Mvududu & Sink, 2013). EFA is a method of factor analysis to identify the relationship between manifest variables or indicators in constructing aspects. The main criteria for EFA are Kaiser-Meyer Olkin price (KMO) > 0.50 (Yong & Pearce, 2013) and communality between 0.60 and 0.80 (Goretzko et al., 2021).

5 RESEARCH RESULT

5.1 ENVIRONMENTAL SENSITIVITY INSTRUMENT DEVELOPMENT PRODUCT

The results of the study of secondary literature sources in the form of books and scientific articles, a grid of environmental sensitivity attitude instruments for students related to GCP was compiled as shown in Table 1. This grid contains the dimensions of environmental sensitivity, GCP orientation, and statements or indicators (positive or negative).

Table 1. Green Chemistry Principles (GCP) Oriented Environmental Sensitivity Grid

Nu.	Dimensions	GCP orientation	Items		Amount
			Positive attitude	Negative attitude	
1	Harmony of life and diversity	GCP 1 GCP 6	1, 4, 9, 13	14	5
2	Environmental Balance	GCP 1 GCP 6 GCP 12	2, 3, 5, 6, 19, 20	16	7
3	Mutual dependence	GCP 1 GCP 6	7, 10, 17, 24	8, 25	6
4	Sustainable (SDGs)	GCP 1 GCP 6 GCP 12	11, 12,15, 18, 21, 23	22	7
Amount			20	5	25

Source: Manahan, S.E., 2006

The total items developed in the form of attitude statements are 25 items. The complete instrument can be seen in Appendix 1.

5.2 CONTENT VALIDITY TESTING WITH CVR

The results of testing the content validity using the CVR technique are presented in Table 2. It appears that of the 25 ESI items, there are twenty-four items in the good validity category and one item in not good category. Only twenty four valid items included were included again. So for the follow-up test Item 18 is no longer included.

Table 2. Validation Calculation Using Lawshe's CVR Index

Item	Value			Total SME	CVR Value	Information
	Essential	Useful not essential	Not required			
1	8	0	0	8	1	Good
2	8	0	0	8	1	Good
3	7	1	0	8	0.75	Good
4	8	0	0	8	1	Good
5	8	0	0	8	1	Good
6	8	0	0	8	1	Good
7	7	0	1	8	0.75	Good
8	8	0	0	8	1	Good
9	8	0	0	8	1	Good
10	8	0	0	8	1	Good
11	8	0	0	8	1	Good
12	8	0	0	8	1	Good
13	8	0	0	8	1	Good
14	8	0	0	8	1	Good
15	8	0	0	8	1	Good
16	8	0	0	8	1	Good
17	8	0	0	8	1	Good
18	4	4	0	8	0	Not Good
19	8	0	0	8	1	Good
20	8	0	0	8	1	Good
21	8	0	0	8	1	Good
22	7	1	0	8	0.75	Good
23	8	0	0	8	1	Good
24	8	0	0	8	1	Good
25	8	0	0	8	1	Good

Source: Results of Statistics data processing with SPSS, 2023

The grouping of the 24 items in the good validity category according to the dimensions of environmental sensitivity is given in Table 3. The descriptions are five items for the dimensions of harmony of life and diversity; seven items for environmental balance; six items for mutual dependence; six items for the sustainable dimension.

Table 3. Good Validity Category Items Grouped by Dimension

Statement of Environmental Sensitivity		Question Code
Dimension 1: Harmony of life and diversity		
1	I turn on the light all time so that it doesn't feel dark	A1
4	I prefer to be in an open space with fresh air than in a closed room with air conditioning	A2
9	I like it when the school environment is clean and orderly	A3
13	I am happy to invite my friend to picket cleaning on his schedule	A4
14	I didn't turn off the light even though it was already noon	A5
Dimension 2: Environmental Balance		
2	I think it's important to sort organic and inorganic waste	B1
3	Teachers always encourage students to preserve the environment	B2
5	Preserving the environment by greening the yard is important to maintain the balance of nature	B3
6	I feel proud when I throw trash in the bin	B4
16	I think it's normal to throw food wrappers under the classroom table	B5
19	I use substances as necessary during practicum	B6
20	My teacher recommends the use of environmentally friendly materials during practicum	B7
Dimension 3: Mutual dependence		
7	In my opinion, waste paper, food packaging and used bottles become a nest of bacteria	C1
8	I imitate the actions of other people who litter	C2
10	I rebuke my friend who throws trash out of place	C3
17	I use water as needed when practicum in the laboratory	C4
24	Despite our special abilities humans are still subject to the laws of nature	C5
25	Humans have the right to modify the natural environment to suit their needs	C6
Dimension 4: Sustainable		
11	In my opinion, teachers should teach me how to manage waste properly	D1
12	I recycle used goods into more useful items	D2
15	I use protective equipment when practicing in the Laboratory	D3
19	I like to plant in the yard of the house	D4
22	I prefer to use the elevator even though it's only a few floors	D5
23	I prefer to walk to places that are not too far away	D6

Source: Morgil, İ., Arda, S ., Secken, N., Yavuz, S., & Özyalçın Oskay, Ö., 2004

5.3 EXPLORATORY FACTOR ANALYSIS (EFA) RESULTS

EFA is a statistical method used to build models consisting of many variables. EFA is used when the initial information about the grouping of indicators that has been made is not clear enough. Before proceeding to exploratory factor analysis (EFA), it is necessary to prove the adequacy of the sample by the KMO and Bartlett tests. The sample is considered sufficient if the KMO Measure of Sampling Adequacy value is more than 0.50. Table 4 present the results of KMO and Bartlett tests.

Table 4. Result of KMO and Bartlett Tests

KMO Measure of Sampling Adequacy	**.762**
Bartlett test of Sphericity Approx. Chi-Square	930.978
df	300
Sig.	.000

Source: Mvududu & Sink, 2013

Table 4 shows that:

A. The KMO value is 0.762, more significant than 0.50, indicates that the sample used in research is sufficient.This means that 116 samples are sufficient for testing the validity and reliability of the instrument.

B. The Sig value obtained is 0.000 indicating that the research variables can be predicted and analyzed further.

C. Bartlett Sphericity Test Approx. $\chi 2$ was obtained at 930,978 at a significance of 0.000, indicating a significant correlation between variables.

Based on these results it indicates that a trial sample of 116 respondents is sufficient for further analysis. Explanation of the correlation matrix to see if each item has a consistent relationship because being between 0.05 and 0.9 indicates each item is related. Then analyze the resulting anti-image matrix as shown in Table 5. Santoso (2002) states that the requirements for factor analysis are that the Measures of Sampling Adequacy (MSA) value must be more than 0.50 in the Anti-image Correlation for each item with the item itself.

Table 5. Summary of Measurements of Sampling Adequacy (MSA) and Communality Anti Image Correlation Price r Initial Extraction Code

Anti Image Correlation	Value of r	Code	Initial	Extraction
A1-A1	0.724	A1	1,000	0.609
A2-A2	0.675	A2	1,000	0.694
A3-A3	0.703	A3	1,000	0.760
A4-A4	0.858	A4	1,000	0.681
A5-A5	0.688	A5	1,000	0.762
B1-B1	0.823	B1	1,000	0.652
B2-B2	0.778	B2	1,000	0.679
B3-B3	0.865	B3	1,000	0.614
B4-B4	0.607	B4	1,000	0.645
B5-B5	0.658	B5	1,000	0.636
B6-B6	0.750	B6	1,000	0.790
B7-B7	0.835	B7	1,000	0.688
C1-C1	0.728	C1	1,000	0.714
C2-C2	0.777	C2	1,000	0.649
C3-C3	0.840	C3	1,000	0.686
C4-C4	0.734	C4	1,000	0.649
C5-C5	0.765	C5	1,000	0.732

C6-C6	0.822	C6	1,000	0.561
D1-D1	0.819	D1	1,000	0.623
D2-D2	0.815	D2	1,000	0.615
D3-D3	0.750	D3	1,000	0.667
D4-D4	0.784	D4	1,000	0.612
D5-D5	0.751	D5	1,000	0.722
D6-D6	0.643	D6	1,000	0.660

Source: Santoso, 2002

Communality serves to ensure data does not diverge in factor analysis. Table 5 shows that the extraction value is in the range of 0.609 to 0.790 which indicates that 24 items are worthy of investigation and can be continued in testing to determine environmental sensitivity according to the variables or dimensions of the instrument. The results of the EFA follow-up test with the matrix components as shown in Table 6 show that the first factor is the environmental balance dimension; the second factor is the harmony of life and diversity; the third factor is mutual dependence; and the fourth factor is the sustainable dimension.

Table 6. Component Matrix

Item	Componen			
	1	2	3	4
A1	0.045	0.789	0.149	0.103
A2	0.115	0.694	0.032	0.129
A3	0.036	0.760	0.061	0.117
A4	0.190	0.681	0.123	0.122
A5	0.188	0.762	0.059	0.032
B1	0.645	0.052	0.067	0.149
B2	0.636	0.079	0.021	0.032
B3	0.790	0.114	0.049	0.161
B4	0.688	0.145	0.032	0.123
B5	0.645	0.136	0.161	0.159
B6	0.636	0.190	0.023	0.167
B7	0.790	0.188	0.059	0.122
C1	0.188	0.014	0.667	0.032
C2	0.049	0.049	0.702	0.160
C3	0.132	0.186	0.732	0.149
C4	0.149	0.149	0.649	0.073
C5	0.032	0.032	0.802	0.161
C6	0.161	0.061	0.661	0.023
D1	0.023	0.023	0.123	0.659
D2	0.159	0.159	0.159	0.667
D3	0.067	0.067	0.167	0.682
D4	0.122	0.037	0.150	0.722
D5	0.020	0.12	0.151	0.660
D6	0.160	0.170	0.103	0,752

Source: Results of Statistics data processing with SPSS, 2023

Table 6 shows the loading factor is more than 0.5 and does not overlap. These results indicate the order of factors as follows:

1. The first factor is Environmental Balance (B); there are seven items for this factor are B1, B2, B3, B4, B5, B6, and B7.
2. The second factor is Harmony of life and diversity (A); these factor items are A1, A2, A3, A4, and A5.
3. The third factor is Mutual dependence (C); these factor items are C1, C2, C3, C4, C5, and C6.
4. The fourth factor is Sustainable (D); these factor items are D1, D2, D3, D4, D5, and D6.

Table 7. Exploratory Analysis Result

Environmental Sensitivity Attitude Items		**Faktor Loading**
Factor 1: Environmental Balance		
2	I think it's important to sort organic and inorganic waste	0.645
3	Teachers always encourage students to preserve the environment	0.636
5	Preserving the environment by greening the yard is important to maintain the balance of nature	0.790
6	I feel proud when I throw trash in the bin	0.688
16	I think it's normal to throw food wrappers under the classroom table	0.645
19	I use substances as necessary during practicum	0.636
20	My teacher recommends the use of environmentally friendly materials during practicum	0.790
Factor 2: Harmony of life and diversity		
1	I turn on the light all time so that it doesn't feel dark	0.789
4	I prefer to be in an open space with fresh air than in a closed room with air conditioning	0.694
9	I like it when the school environment is clean and orderly	0.760
13	I am happy to invite my friend to picket cleaning on his schedule	0.681
14	I didn't turn off the light even though it was already noon	0.762
Factor 3: Mutual dependence		
7	In my opinion, waste paper, food packaging and used bottles become a nest of bacteria	0.667
8	I imitate the actions of other people who litter	0.702
10	I rebuke my friend who throws trash out of place	0.732
17	I use water as needed when practicum in the laboratory	0.649
23	Despite our special abilities humans are still subject to the laws of nature	0.802
24	Humans have the right to modify the natural environment to suit their needs	0.661
Factor 4: Sustainable		
11	In my opinion, teachers should teach me how to manage waste properly	0.659
12	I recycle used goods into more useful items	0.667
15	I use protective equipment when practicing in the Laboratory	0.682
18	I like to plant in the yard of the house	0.722
21	I prefer to use the elevator even though it's only a few floors	0.660
22	I prefer to walk to places that are not too far away	0.752

Source: Results of Statistics data processing with SPSS, 2023

5.4 RELIABILITY TESTING

Reliability testing is carried out on items that are declared to have good validity based on previous tests. Thus only 24 items from the four dimensions of environmental sensitivity were involved in this test. The results of the analysis with SPSS for windows using Cronbach's Alpha (as shown in Table 8) obtained the reliability value of 0.792 in the high reliability category.

Table 8. Reliability Analysis Results

Reliability Statistics	
Cronbach's Alpha	N of Items
.792	24

Source: Results of Statistics data processing with SPSS, 2023

6 DISCUSSION

Environmental sensitivity is an important aspect of attitude to measure. Research (Morgil, et al. 2004) suggests that environmental sensitivity is part of environmental awareness and is related to environmental knowledge. Environmental awareness and environmental knowledge can increase with an action that makes it a habit. The significant influence between the implementation of learning processes that can stimulate an attitude of environmental awareness has been reported by previous researchers; the use of computer assisted education (CEA) by (Morgil et al. (2004) Flanagan (2019); environmental education is needed to raise awareness of the surrounding environment (Chen et al., 2020; Flanagan et al., 2019; Moseley et al., 2019 ;Woosnam et al., 2018).The facts show that students' attitudes in the learning process are very important and can predict achievement in chemistry in general (Xu and Lewis, 2011).The environmental sensitivity attitude instrument produced consisted of 24 items which were declared valid and reliable. in four dimensions or factors and their order changes based on the results of the EFA analysis, namely: 1) Environmental Balance; 2) Harmony of life and diversity; 3) Mutual dependence; and 4) Sustainable.

The four dimensions in this instrument are closely related to the principles of green chemistry which is of course an important matter in learning chemistry at the high school level. Students as the next generation need to be equipped with a sense of sensitivity to the surrounding environment. This attitude does not appear suddenly, it needs stimulation and real action. This concrete action by the teacher can be

implemented and integrated into the learning process continuously. Environmental balance as one of the dimensions is deemed necessary to be a focus because it is related to GCP number one pollutant; GCP six on increasing energy efficiency; and GCP 12 minimizes the potential for accidents (Anasstas & Werner, 1998; Manahan, 2006). The Harmony dimension is related to the first dimension but the emphasis is more on arrangement, beauty, and diversity. Related GCP orientations are GCP on Preventing waste and GCP on Improving energy efficiency. The positive interdependence dimension implies that life needs to be mutually beneficial and look after each other for sustainability. Overall there are three GCPs related to environmental sensitivity attitude instruments namely, Preventing waste, Improving energy efficiency, and Minimizing the potential for accidents.

7 CONCLUSION

The results showed that the instrument for assessing environmental sensitivity in GCP-oriented chemistry learning was declared valid and reliable because it met all the criteria of content validity with CVR, construction validity with EFA, and high instrument reliability. The findings of this study add to knowledge and information about assessment in the realm of environmental sensitivity which of course greatly contributes to learning. There are so many phenomena of environmental damage that need to be addressed around us and that requires a sense of care and sensitivity from teachers, students and the community. Chemistry teachers or other researchers can use this instrument to find out attitudes in the form of students' sensitivity to GCP-oriented environments.

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