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# HOW IS THE DIGITAL-BASED ECOLOGICAL COMPETENCE ASSESSMENT IN UNIVERSITY

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**Abstract**

To address the shortage of authentic assessment tools for ecological competence and positive character in students, this research evaluated the effectiveness of newly developed instruments through problem-based learning on environmental change and waste recycling. The study used a mixed approach with an explanatory sequential design, and data was collected through questionnaires, measurements, observation sheets, and documentation. The results showed that the newly developed instruments had high validity and reliability in assessing ecological competence and positive character, but no significant difference was found in positive character assessment between the experimental and control groups. The research highlights the importance of authentic assessment of attitudes, psychomotor skills, and character in learning assessments and suggests further research to enhance positive character assessment instruments.

**Keywords:** Assessment, Ecological Competence, Positive Character, Digital.

## INTRODUCTION

To determine the level of achievement of student performance which refers to the formation of student attitudes and character(Muhaimin, 2020), a rubric for assessing student attitudes and character is needed as a guide in assessing student performance and learning outcomes.(Sudaryanto & Akbariski, 2021) Based on several existing national journals, the availability of psychomotor assessment instruments in schools is still limited, namely only performance assignments and questions without reference to the formation of students' positive attitudes and character.(Rukmini & Saputri, 2017) Thus scoring guidelines (rubrics) and observation sheets are generally not available in schools. Therefore, the author tries to make a rubric for assessing students' ecological competence and character so that teachers can better assess the affective domain, and the character possessed by students in addition to student learning outcomes.(Briones et al., 2022)

Ecological competency learning refers to an understanding of hidden ecological impacts and problem-solving, combining cognitive skills and empathy for all forms of life(Muhaimin, 2020). In connection with various environmental damages environmental problems that occur cannot be separated from human behavior. (Joseph, 2006) The habit of using disposable products affects the amount of piles of waste. The decrease in the groundwater level is due to uncontrolled exploitation of hotels and apartments, while there is land conversion in the rain catchment area. Floods are triggered by deforestation in the upstream areas of rivers and piles of garbage in waterways.(Hidayat et al., 2021)

In solving the waste or waste problem, the national waste management policy has been regulated in Law No. 18 of 2008, There have been many ways to deal with waste, including: burying it and collecting it in a landfill(Rao, 2022), composting, burning or converting it into other energy(Roy et al., 2022). In addition, several stakeholders can contribute to solving waste problems including 1) waste management, 2) government, 3) education, and 4) other state management institutions.(Tennakoon & Kulatunga, 2021) As for the education sector, what is usually done to manage waste is to provide knowledge and understanding to all school or education components about waste and its management, in this case, this understanding must be given to students. (Stegmann, 2013) In practice, the process of providing understanding and awareness of waste management is carried out in teaching and learning activities such as science learning which is closely related to environmental issues.

To overcome these problems, we need a learning process that can accommodate students to play an active role in environmental preservation in the form of waste management. (Mihai et al., 2022) This can increase students' concern for the environment because environmentally sound attitudes and behavior can be pursued through education. In this case, the school as a learning environment plays a role in empowering attitudes, because in the learning process, there is a process of communication and transfer of knowledge and values. As stated by Sani (2015) attitudes can grow and be developed through the learning process.

Many studies related to the growth of students' caring attitude towards the environment in the learning process, both using a learning model (Simbolon, 2020), the use of teaching materials such as learning media(Istiqomah et al., 2020), and modules that directly associated with environmental care attitudes (Santri et al., 2022),(Debora Indriani et al., 2019). Of the many ways that have been done to increase caring attitudes or environmental awareness.

The environmental damage that is happening widely at this time increasingly highlights the importance of caring for the environment, but this is unfortunate because environmental education(Ballantyne & Packer, 2008) does not form student behavior that is friendly to the environment. (Muhaimin, 2020)stated that the reason for the failure was due to the learning approach used by the teacher in eco-pedagogy that did not explore students to obtain information, conduct analysis, and make decisions based on inquiry so that the material provided did not become behavior displayed daily.

The last curriculum emphasizes the existence of learning assessments which include authentic assessments of attitude, psychomotor, and character(Achmad & Prastowo, 2022) which must be carried out by the principles of assessment such as objective, continuous, and accountability. (Azhar, 2018) Researchers will try to develop assessments (assessments) to increase ecological competence and student character. The aims of this study were (1) to examine the functioning of the ecological competency assessment developed on Ecological material on environmental change at universities, (2) to analyze differences in ecological competence between students who were assessed using the ecological competency assessment developed and students who were assessed without using an ecological competency assessment in environmental change Ecological material at the university, (3) Analyze the positive character differences between students who are assessed using the positive character assessment developed and students who are assessed without using the positive

character assessment on the Ecological material for changes in the waste environment at the university.

## MATERIAL & METHODS

This research method uses mixed methods with an explanatory sequential design. The sampling technique uses simple random sampling. The population of the Study Group of Biology Education students at Kuningan University was 105 divided into 3 classes, where one class consisted of 35 people. Data collection techniques used tests, questionnaires, self-assessments, and observation sheets. Data analysis used descriptive analysis techniques and mean difference tests for quantitative data(Ali, 2021), and triangulation techniques for qualitative data.(Abdalla et al., 2018)

## RESULTS

The results of constructive validation from material experts are presented as follows

**Table 1: Constructive Validation of the Ecological Competency Questionnaire Assessment Instrument**

| Equipment | Validator Assessment 1 | | Validator Assessment 2 | |
|---|---|---|---|---|
| | Sum | Percentage | Sum | Percentage |
| Ecological Competency Assessment Instrument | 48 | 87,27% | 49 | 89,09% |
| Mean and Percentage | 48,5 | | 88,18% | |

Table 1 above shows that the ecological competency questionnaire instrument was given a value by validator I of 48 out of a maximum total score of 55 with a percentage of 87.27%. While validator II gives a value of 49 out of a maximum score of 75 or 89.09%. Then the average evaluation of the validation of the ecological competency questionnaire assessment tool is 48.5 or a percentage of 88.18%. So it can be concluded that the ecological competency questionnaire instrument is valid or has very high validity.

Empirical validation was also carried out through trials of research instruments in the form of attitude questionnaires and ecological competency performance for students outside the sample. Respondents used for testing the ecological competency questionnaire instrument were 30 students according to the minimum large sample size requirements for parametric statistical testing (Memon et al., 2020). Validity testing is also carried out through expert assessment of content validity to test whether the developed instrument has relevant content, and relevant methods and objectives(Yaghmaie, 2003) (Nursalam, 2011). The results of testing the content validity of the ecological competency performance measurement instruments are presented in the table below.

**Table 2: Content Validity of Ecological Competency Performance Measurement Instruments**

| No | Assessment Aspects | Validator 1 | Validator 2 |
|---|---|---|---|
| 1 | Material | 100 % | 100 % |
| 2 | Construction | 92,48 % | 92,82% |
| 3 | Language/Culture | 100 % | 100 % |
| Average Percentage per Validator | | 95,37 % | 95,58% |
| Overall Average Percentage | | 95,47% | |

The outcomes of the first and second validators' evaluations are presented in Table 2, indicating the content validity of the ecological competency performance measurement instrument. The average percentage of the first validator's assessment was 95.37%, while the second validator's evaluation resulted in an average of 95.58%. Based on these findings, it can be inferred that the ecological competency measurement tool's content validity falls within the very high category.

Testing the reliability of the instrument for measuring the performance of ecological competence is carried out through inter-rater reliability with 2 (two) assessors. The results of the two assessors' inter-rater reliability test showed an inter-rater coefficient of 1.0 > 0.7. Thus it can be concluded that the reliability of the instrument for assessing the performance of ecological competence is in the very high category.

Testing the second assessment instrument is the positive character assessment of students which includes the character of discipline, honesty, and responsibility. The results of the two-class content validity test showed an intra-class correlation coefficient of 0.667 which was included in the high category. Testing the reliability of the student positive character assessment instrument was carried out through inter-rater reliability with 2 (two) assessors showing a Cronbach alpha coefficient of 0.667. Based on the results of the reliability test, it can be concluded that the reliability of the instrument for assessing the positive character of students is included in the high category.

**The Effectiveness of the Developed Ecological Competency Questionnaire Instrument**

The results of the research in the form of filling out the ecological competency questionnaire per indicator are presented in Table 3 as follows.

**Table 3: Comparison of Ecological Competence per Indicator of Both Classes**

| No | Indicator | Percent EG | Percent CG |
|---|---|---|---|
| 1 | Appreciation and concern for the environment | 86,79 | 87,02 |
| 2 | Respect people's opinions about the environment | 81,14 | 84,29 |
| 3 | Appreciate the evidence and arguments regarding environmental management | 82,98 | 86,43 |
| 4 | Tolerance and openness in environmental management | 83,37 | 84,80 |
| | Average Percentage | 80,31 | 82,24 |

Table 3 presents a contrast of the findings obtained from completing the ecological competency questionnaire among the experimental group (EG) and the control group (CG). The comparison demonstrates that the achievement of ecological competence was highest on the first indicator and lowest on the fifth indicator for both groups. As for testing the validity of the contents of the competency performance measurement questionnaire provided by experts (expert validation) are as follows:

**Table 4: The validity of the contents of the Ecological Competency Performance Measurement Questionnaire**

| Equipment | Validator Assessment 1 | | Validator Assessment 2 | |
|---|---|---|---|---|
| | Sum | Percentage | Sum | Percentage |
| Ecological Competency Performance Assessment Instrument | 1342 | 95,58% | 1339 | 95,37% |
| Average Percentage | 95,47 | | | |

Based on table 4 the results of the analysis of ecological competency performance measurements, the first validator's assessment reached a percentage of 95.58%, while the second validator's assessment reached 95.37%. Based on the results of the content assessment, it can be concluded that the content validity of the instrument for measuring the performance of ecological competence is valid or the instrument has very high validity.

The results of the assumption test on the ecological competency questionnaire data show that the data is normally distributed and homogeneous. The results of the t-statistical test showed that there was an average difference in the results of filling out the ecological competency questionnaire between the experimental class and the control class. This is evidenced by the tcount of 2.890 > ttable of 2.02 and a significant (p-value) of 0.007 which is greater than 0.05.

A statistical comparison was made between the experimental class and the control class concerning the ecological competence performance measurements. The normality and homogeneity tests showed that the data was evenly distributed and uniform. The outcome of the average ecological competency performance difference test between the experimental and control classes is tabulated in Table 5.

**Table 5: Results of the Mean Difference Test on Ecological Competency Performance Data**

| Compare | | T | Df | *Sig. (2-tailed)* | Meaning |
|---|---|---|---|---|---|
| Pair 1 | IG – CG | 2,560 | 34 | 0,015 | Ho rejected, Ha accepted |

As indicated in Table 5, a distinction exists in the mean ecological competency performance of the experimental class compared to the control class. This is supported by the t-count of 2.560, which is greater than the t-table of 2.02, and the p-value of 0.015, which is less than the significance level of 0.05

## Description of Student Positive Character Measurement Data through Self-Assessment

The students' positive character assessment reveals that the experimental class had a lower average self-assessment value compared to the control group. The normality statistical test results revealed that the self-assessment data from both the experimental and control classes were not normally distributed. Table 6 illustrates the outcome of the average difference test for the self-assessment data between the experimental class and the control class.

**Table 6: Results of the Mean Difference Test of Student Self-Assessment Data**

| Test Statistics[b] | |
|---|---|
| | SA-IG - SA-CG |
| Z | -.446[a] |
| Asymp. Sig. (2-tailed) | .656 |

Table 6 demonstrates that the Wilcoxon test did not find any significant difference in the mean self-assessment of students between the experimental class and the control class. This is supported by the Zcount value of 0.446, which is less than Ztable, and the p-value of 0.656, which is greater than the significance level of 0.05. Moreover, the teacher's observation of students' positive character showed that their characteristics, such as discipline, honesty, conscientiousness, and cooperation, in both the

experimental and control groups were excellent, reaching a percentage greater than 85%.

## DISCUSSION

The research evaluated the ecological competence assessment instruments and the positive character of students using three validity types, namely constructive validity, empirical validity, and content validity. The analysis of the constructive validity of the ecological competency questionnaire showed a percentage of 88.18, which was in the very good category. The validator provided feedback on the ecological competency questionnaire instrument, suggesting that items containing double negatives or not aligned with the student's knowledge and understanding should be eliminated

Based on the results of empirical validity testing of the ecological competency questionnaire instrument, information was obtained that the questionnaire was valid with validity ranging from 0.451 to 0.981. The results of the instrument reliability test showed a Cronbach alpha coefficient value of 0.974 > 0.7 which indicated a reliable questionnaire instrument. In testing the instrument for measuring the performance of ecological competence, the validity moved from 0.421 to 0.967 so the questionnaire for measuring the performance of ecological competence had very high validity. Empirical testing of the reliability of the performance measurement questionnaire shows a Cronbach alpha coefficient value of 0.971, which means that the performance questionnaire measuring ecological competence has very high reliability.

The results of testing the content validity of the ecological competency performance measurement instrument reached a percentage of 95.47% which was in the very high category. Empirical reliability testing of the ecological competency questionnaire instrument through Cronbach's Alpha value obtained a coefficient value of 0.974 or very high reliability. Analysis of the questionnaire instrument and the instrument for measuring the performance of ecological competence uses performance test analysis. This is done because the references from the test analysis of these actions can determine the value and quality of the questions. There are 3 (three) aspects contained in the analysis of the action test. These three aspects are material, construction, and language/cultural aspects which consist of 13 categories. The results of the research on the ecological competence of students through this questionnaire also revealed that the percentage of scores was better in the control group with achievement of 87.02%, while in the experimental group with 86.79%. Likewise in the fifth indicator which is the lowest indicator among the five indicators, the percentage of the control group is 82.24% better than the experimental group 80.31. The achievement of better ecological competence in the control group could be due to the implementation of the assessment using a problem-based learning model according to the 2013 curriculum which is not like ordinary learning where students are not informed about the aspects to be assessed in learning. Whereas in the authentic assessment according to the 2013 curriculum it was stated that the aspects to be assessed were informed to students so that students felt more afraid and awkward with the authentic assessment of learning based on the latest curriculum.

The results of this study are also in line with the results of research by Kose (2015) who found that (1) case studies in character education correspond to the positive aspects of adolescent development, (2) the educational environment for character education must consider the curriculum, school environment(Adams, 2011), the roles

and responsibilities of teachers(Veronika & Dafit, 2022), as well as good cooperation between parents(Retnasari et al., 2021), schools and the environment(Nurdin, 2020).

The results of this study indicate that the average self-assessment value of students in the experimental class is lower than that of the control class. Qualitative assessment of students' (positive) characters conducted by the teacher through the teacher's observation sheet shows the percentage of students' (positive) characteristics which include the characteristics of honesty, discipline, conscientiousness, and cooperation has reached a percentage above 85% in the experimental class (EC) and class control (CG) where the percentage of experimental class students' characters was higher than the control class. Based on the results of measuring the (positive) character of students through self-assessment and teacher assessment, it shows that character assessment by students (self-assessment) is better in the control class, while character assessment by the teacher is better in the experimental class. There are differences in the results of the qualitative self-assessment of students (self-assessment) and the teacher's assessment is a natural thing to happen because of differences in perspectives, knowledge, and life experiences. Contradictions in the results of student (positive) character assessment by students and teachers can be caused by students feeling more aware of their character, while teachers provide character assessments based on the principles of learning assessment in authentic assessment following the applicable curriculum (2013). So even though there are slight differences, in essence, they are the same, namely Students who are respondents to this study have positive characteristics in this case being honest, disciplined, responsible, and able to work together with friends/other people.

According to the findings of this study, it was discovered that the positive character traits of students, such as honesty, discipline, and responsibility, were in line with the latest curriculum guidelines. (Volume, 2015) These guidelines stipulate that high school and vocational school graduates should possess the abilities to think and act effectively and creatively, in both abstract and concrete realms, based on their experiences(Henriksen et al., 2016). Furthermore, the present study supports the conclusions of earlier research, including the (Muthohar, 2021) study, which identified the character values that need to be instilled in students, effective models for instilling such values, and successful learning patterns for character development. Similarly, (Jalil et al., 2018) research on the development and validation of a Physics ability test for high school students found that the test exhibited strong psychometric properties.

Moreover, the current study aligns with the findings of Jalil et al's research on the high reliability of the science process skills assessment rubric, which had a reliability coefficient value of 0.802. Finally, the results of the present study are consistent with the research of (Foroudi et al., 2020), which discovered that assessments designed to measure character actualization in students were effective in promoting successful acculturation and character empowerment. The results of this study are also in line with the research (Taber, 2018) which stated that researchers had used the Cronbach Alpha coefficient value as a whole to show strong internal consistency.

## CONCLUSION

After conducting the research and discussing the results, the following conclusions can be drawn: (1) The assessment of ecological competence was highly effective with an 88.18% rate, and the content validity of the assessment instrument for measuring

ecological competence was very high at 95.47%. Additionally, the content validity of self-assessment of students' positive character was high at 0.667. The reliability of the ecological competency questionnaire instrument was very high at 0.974, and the reliability of the ecological competency performance measurement instrument was also very high at 1.0. The reliability of the student positive character assessment instrument was high at 0.667. Therefore, the assessment instruments for ecological competence and positive character have met the principles of learning assessment with very high validity and reliability, (2) A significant difference in ecological competence was found between the experimental class and the control class, as evidenced by the probability value (p-value) of 0.015 < 0.05, (3) No significant difference was found between the positive character of students (honesty, discipline, responsibility) in the experimental class and the control class during the implementation of positive character assessment, as evidenced by the probability value (p-value) of 0.656 > 0.05.

## CONTRIBUTION/ORIGINALITY

Universities should focus on developing their students' ecological competence by incorporating digital tools and technology into their teaching and learning methods. This will prepare students to be responsible citizens who are aware of the environmental impact of their actions and equipped to make sustainable decisions.

Furthermore, the research suggests that universities should adopt an assessment model to measure students' ecological competence. This will help universities to identify areas where students may need further support and to evaluate the effectiveness of their teaching methods. The digital-based assessment model proposed by the research will also enable universities to collect and analyze data on students' ecological competence, which can be used to improve the curriculum and teaching methods. This will ultimately benefit society as a whole by producing graduates who are environmentally conscious and capable of promoting sustainability in their communities. In summary, the research highlights the importance of integrating ecological competence into university curricula and using digital-based assessment models to evaluate students' understanding and promote sustainability.

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**Author contributions**

All authors made equal contributions to the study

**Declaration of conflicting interests**

The author(s) stated that they have no potential conflicts of interest concerning the research, authorship, and/or publication of this article

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