



Development of Attitude Assessment Instruments in Environmental Pollution Practicum Activities

**Nadiah Danisha Putri^{*}, Sarah Talia, Rizhal Hendi Ristanto,
Dini Safitri, Fitria Pusparini**

Program Studi Pendidikan Biologi, Fakultas Matematika dan Ilmu Pengetahuan Alam,
Universitas Negeri Jakarta

*Email: naishaa29@gmail.com

Article Information	ABSTRAK
Submitted: 23 – 12 – 2024 Accepted: 26 – 03 – 2025 Published: 31 – 03 – 2025	Penilaian pada kegiatan praktikum hanya berfokus pada aspek kognitif dan psikomotor, sementara penilaian sikap cenderung terabaikan. Kondisi ini menunjukkan perlunya pengembangan instrumen penilaian sikap yang valid dan reliabel untuk mendukung penilaian yang lebih komprehensif. Penelitian ini bertujuan untuk mengembangkan instrumen penilaian sikap berbasis teknik observasi yang tervalidasi dan reliabel dalam konteks kegiatan praktikum pencemaran lingkungan. Penelitian ini menggunakan jenis penelitian pengembangan (<i>Research and Development</i>) dengan desain pengembangan yang mengacu pada model ADDIE. Subjek penelitian ini meliputi: (1) Tiga validator ahli yang merupakan dosen Pendidikan Biologi, dan (2) 36 peserta didik kelas X.A SMAN 89 Jakarta. Analisis data dilakukan melalui validasi logis oleh para ahli serta uji validitas empiris dan reliabilitas menggunakan analisis korelasi Product Moment dan rumus reliabilitas <i>Cronbach's Alpha</i> . Hasil validasi logis yang dilakukan oleh tiga ahli menunjukkan bahwa penilaian sikap yang dinilai semuanya valid, dengan rata-rata sebesar 78,36%. Pada tahap implementasi dilakukan uji validitas empiris dan reliabilitas terhadap 36 siswa dan diperoleh delapan aspek sikap valid dengan hasil r hitung > r tabel. Kemudian semua aspek sikap yang valid diuji reliabilitasnya dan didapatkan hasil 0,422, sehingga instrumen yang dikembangkan termasuk dalam kategori cukup reliabel. Kata kunci: Pengembangan; Penilaian sikap; Instrumen.
Publisher	ABSTRACT
Program Studi Pendidikan Biologi, Fakultas Sains dan Teknologi, UIN Walisongo Semarang	<i>Assessment in practical activities only focuses on cognitive and psychomotor aspects, while attitude assessment tends to be neglected. This condition indicates the need to develop a valid and reliable attitude assessment instrument to support a more comprehensive assessment. This study aims to develop an attitude assessment instrument based on validated and reliable observation techniques in the context of environmental pollution practical activities. This study uses a type of development research (Research and Development) with a development design that refers to the ADDIE model. The subjects of this study include: (1) Three expert validators who are lecturers of Biology Education, and (2) 36 students of class X.A SMAN 89 Jakarta. Data analysis was carried out through logical validation by experts and empirical validity and reliability tests using Product Moment correlation analysis and Cronbach's Alpha reliability formula. The results of the logical validation carried out by three</i>

experts showed that the attitude assessments assessed were all valid, with an average of 78.36%. At the implementation stage, empirical validity and reliability tests were conducted on 36 students and obtained eight valid attitude aspects with calculated r results $> r$ table. Then all valid attitude aspects were tested for reliability and the result was 0.422, so that the instrument developed was included in the fairly reliable category.

Keywords: *Attitude assessment; Development; Instrument.*

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INTRODUCTION

Assessment is one of the main components in the learning process that aims to measure students' competency achievements (Kunandar, 2020; Sudjana, 2019; Widoyoko, 2021). Assessment does not only focus on cognitive aspects, but also includes affective aspects, such as attitudes, values, and character (Kunandar, 2020; Majid & Aep, 2018). This is in line with the holistic goal of education, which is to develop students who are not only intellectually intelligent but also have good character (Majid & Aep, 2018). Attitude assessment is becoming increasingly relevant in this era, given the importance of building a generation with excellent character and the ability to face global challenges with a positive attitude (Kusaeri, 2019; Majid & Aep, 2018; Widoyoko, 2021).

Practical activities are an integral part of science learning that provide students with opportunities to develop process skills, scientific attitudes, and conceptual understanding (Maison et al., 2019). Environmental pollution practicals, as an important topic in biology learning, enable students to analyse environmental issues directly and develop concern for the environment (Astalini et al., 2020; Setiawan et al., 2017). However, although practical activities have great potential in fostering scientific attitudes and environmental awareness, the assessment of these attitudes is still not optimal. Assessment in practical activities generally still focuses on cognitive and psychomotor aspects, while affective aspects are often neglected. Therefore, it is necessary to develop a valid, reliable, and observation-based attitude assessment instrument to obtain a comprehensive picture of students' attitudes during practical activities.

Assessment in practical activities often focuses only on cognitive and psychomotor aspects, while attitude assessment tends to be neglected or carried out in an unstructured manner (Akhyar et al., 2024; Fatnan, 2022). Attitude assessment in science education still faces various challenges, such as the subjectivity of assessors, unclear assessment indicators, and difficulties in observing students' attitudes individually (Astalini & Kurniawan, 2019; Dewi & Rosana, 2017). This is due to the limited availability of valid and reliable attitude assessment instruments for practical activities (Aprianiwati et al., 2020).

Biology teachers at the senior high school level experience significant difficulties in conducting objective and measurable attitude assessment in practical activities, due to the lack of available validated and reliable instruments (Sole & Anggraeni, 2017). Several previous studies have developed attitude assessment instruments in science learning in general. However, they have not specifically highlighted the

application of these instruments in the context of environmental pollution practical activities, which have distinctive observational and applicative characteristics. This condition causes the attitude assessment results to be less accurate and not reflect the actual abilities of the students (Juliani & Erita, 2023). The development of valid and reliable attitude assessment instruments is an urgent need in science learning, especially for practical activities (Yusuf, 2023). A good assessment instrument must be able to measure various aspects of scientific attitudes such as curiosity, honesty, cooperation, responsibility, and concern for the environment (Emda, 2017; Fidelia, 2023; Ulva et al., 2017).

Based on the explanation above, the development of valid and reliable attitude assessment instruments is an urgent need in science education, especially for practical activities. A good assessment instrument must be able to measure various aspects of scientific attitudes such as curiosity, honesty, cooperation, responsibility, and concern for the environment (Emda, 2017; Ulva et al., 2017). Attitude assessment through observation techniques has substantial advantages because it allows direct observation of students' attitudes in a natural and authentic learning context (Anderson, 2017). The use of instruments integrated with systematic observation techniques can be an effective solution in overcoming the problems of attitude assessment. Thus, this study aims to develop a validated and reliable observation-based attitude assessment instrument in the context of environmental pollution practicum activities.

METHODS

This study utilises a research and development approach with a development design based on the ADDIE model developed by Dick and Carey (1996). The ADDIE model consists of five stages: Analyse, Design, Development, Implement, and Evaluate. The ADDIE model is considered suitable for the development of assessment instruments because its steps are specifically designed to facilitate the instrument development process. Each stage consists of several steps that we carried out. These steps can be seen in Figure 1.

Participants involved in this study included: (1) three expert validators who were biology education lecturers, and (2) 36 students from class X.A at SMAN 89 Jakarta. Sample selection was conducted using purposive sampling, considering that the students were conducting practical work on environmental pollution.

This study involved three expert validators consisting of a biology education lecturer, a high school biology teacher, and an education evaluation expert. This number was considered representative because it covered the theoretical, practical, and methodological perspectives needed to assess the overall content validity of the instrument. Based on Sugiyono's (2018) guidelines, the number of three validators met the minimum criteria for conducting content validity testing in instrument development research. The product trial was conducted on 36 tenth-grade students selected using purposive sampling, considering that this number was sufficient to obtain an initial picture of the response patterns and assess the validity and reliability

of the instrument at the limited trial stage. Thus, the selection of the number of validators and respondents was adjusted to the research objectives, namely to obtain relevant and representative input before the instrument was applied on a wider scale.

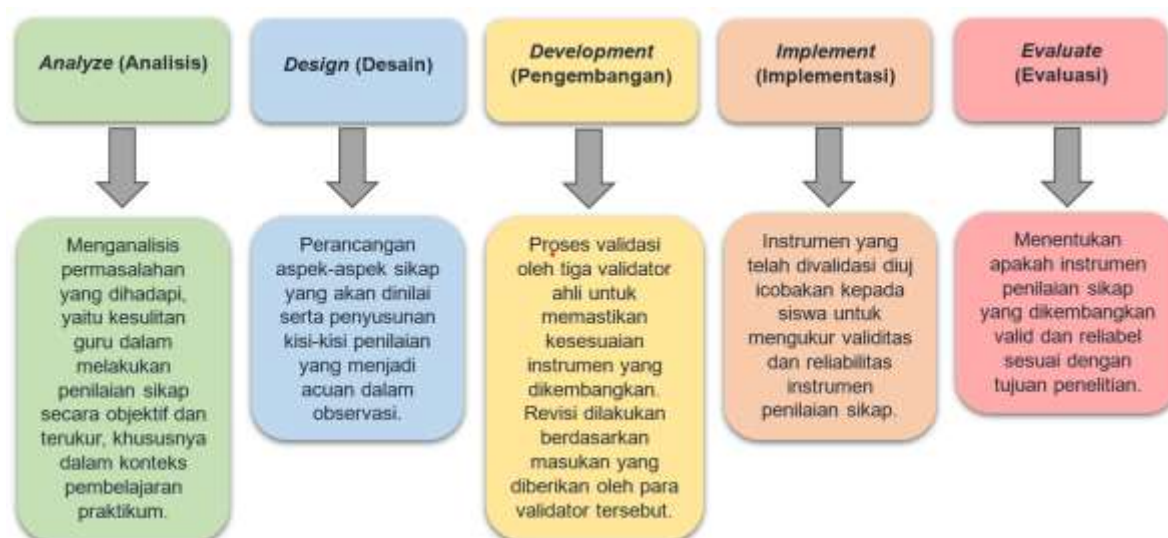


Figure 1. Research Steps

The instruments used in this study were validation sheets and attitude assessment observation sheets with a Likert scale. Data collection techniques used observation and documentation. Observation allowed researchers to record student behaviour in the natural context of practical learning, and documentation complemented the observation by storing physical evidence or records of relevant learning outcomes, such as assessment rubrics.

The data analysis stages in this study consisted of logical validity, empirical validity, and reliability testing. Logical validity was assessed by giving scores to each indicator using a Likert scale, with weights of 5, 4, 3, 2, and 1, which indicated very good, good, fair, poor, and very poor, respectively. The total score for all indicators was calculated based on the assessments given by each validator. Furthermore, the validity value obtained from the assessment results was analysed using a formula referring to (Riduwan, 2012). The instrument was declared theoretically feasible if the validator's assessment reached 61–80%.

Empirical validity testing referred to the use of Pearson's Product Moment correlation. This correlation is used to measure the extent of the linear relationship between two variables, in this case between the scores of each item and the total score, to determine the validity of the item. If the calculated r value is greater than the table r value, the item used is declared valid; conversely, if the calculated r value is smaller than the table r value, the item used is declared invalid. For empirical validity testing, a formula referring to (Arikunto, 2006) is used. Reliability testing uses the Kuder Richardson 20 (KR-20) formula with coefficient classification according to Guilford (1956).

The selection of formulas used in the validity and reliability analysis of the instrument is adjusted to the characteristics of the data and the testing objectives to be achieved. The validity formula referring to Riduwan (2012) is applied because it provides a practical and measurable approach in determining the level of conformity between the indicators and the constructs assessed by experts, making it suitable for use in the content validation stage. To test empirical validity, the Pearson Product Moment correlation formula as described by Arikunto (2006) was used because this method is able to identify the strength of the linear relationship between item scores and total scores, and is suitable for Likert-scale data. Meanwhile, reliability testing was conducted using Cronbach's Alpha, which is considered most appropriate for non-dichotomous data because it can comprehensively describe the internal consistency between items in a single construct. Thus, the three formulas were selected methodologically to be in line with the type of data and stages of instrument development, so that the analysis results obtained were more accurate, consistent, and scientifically accountable.

It is important to match the type of data obtained with the reliability analysis method applied. The instrument used employs a four-point Likert scale to measure the frequency and intensity of students' attitudes, so the data produced is ordinal, not dichotomous. With these characteristics, the application of the Kuder Richardson 20 (KR-20) formula, which is designed for two-category data such as true-false, becomes less relevant. A more appropriate reliability analysis is to use Cronbach's Alpha (α), as this method is able to evaluate the internal consistency between items in data with various response options and take into account the diversity between items in a single construct. From a methodological perspective, Cronbach's Alpha provides a more representative reliability estimation result for observation-based attitude instruments and, theoretically and statistically, is more appropriate for Likert scale data with value levels.

RESULTS AND DISCUSSIONS

The results of this development research are in the form of a standardised evaluation tool designed to measure students' attitudes in practical activities on environmental pollution material. This tool was developed using the ADDIE model and has undergone a validation stage. Revisions were made based on input and suggestions from expert validators to ensure the quality and reliability of the instrument.

The analysis stage began with analysing the problems encountered, namely the difficulties experienced by teachers in conducting objective and measurable attitude assessments, especially in the context of practical learning. The design stage focused on the design of the evaluation tool, including determining the aspects of attitude to be assessed and compiling an assessment grid to serve as a guideline in the observation process. The grid can be reviewed in Table 1.

Table 1. Matrix for Attitude Assessment

No	Aspect	Indicator
1	Spirituality	Students maintain calm and solemnity during worship or prayer activities in the classroom. Students show respect for classmates who are worshipping, such as by remaining silent or not disturbing them while they pray. Students apply religious values in their daily actions in the classroom, such as being honest and not lying.
2	Discipline	Students arrive in the classroom on time. Students wear the full school uniform in accordance with the applicable regulations during class hours. Students submit their homework on time and in accordance with the guidelines or instructions provided.
3	Responsibility	Students complete assignments independently without involving other parties. Students carry out assignments well, with integrity, and on time in accordance with applicable regulations. Students accept the consequences or results of their actions with an open and responsible attitude.
4	Curiosity	Students actively ask questions related to the material being studied. Students proactively seek additional information from various sources to deepen their understanding. Students are able to relate the concepts they have learned to situations and experiences in their daily lives.
5	Thoroughness	Students pay close attention to the instructions given by the teacher and carry out tasks according to the instructions provided. Students check their work or assignments to ensure there are no mistakes or omissions before submitting them. Students take careful and organised notes of important information during the learning process.
6	Environmental Awareness	Students maintain classroom cleanliness by disposing of rubbish in its proper place and following the cleaning rota. Students also help to maintain a comfortable classroom environment by not damaging classroom facilities, such as blackboards, tables and chairs. Students ensure that equipment or books used during lessons are not damaged or lost.
7	Cooperation	Students show respect for the opinions expressed by their group members. Students appreciate the work done by their group members. Students are willing to cooperate with members of other groups in achieving common goals.
8	Politeness	Students use polite and ethical language when communicating with friends and teachers. Students demonstrate good behaviour and respect while in class. Students ask permission before leaving the classroom.

The development stage focused on the process of validating the attitude instruments that had been compiled and developed. Logical validation was carried out to ensure that the instruments met the established standards, followed by revisions based on input from the validators. This process aimed to produce attitude assessment instruments that were valid and suitable for implementation among

students during practical activities on environmental pollution material. The results of the attitude instrument validation can be seen in Table 2.

Table 2. Logic Validity

Validator	Percentage	Category
Validator 1	73,3%	Valid
Validator 2	68,8%	Valid
Validator 3	93%	Very Valid

The results of logical validity show that the attitude assessment instrument has met the validity criteria with the following assessment percentages from each validator: validator-1 scored 73.3%, validator-2 scored 68.8%, and validator-3 scored 93%. These percentages indicate that the developed instrument has met the requirements for use in assessing student attitudes in practical activities on environmental pollution. This validity reflects that each indicator in the instrument has undergone a rigorous testing process and has been approved by experts, making it reliable for assessing student attitudes objectively. The high validity score also confirms that this instrument is relevant to the assessment objectives and is capable of providing accurate information regarding student attitudes.

The validated instrument then entered the implementation stage, where it was tested on students to measure its validity and reliability in measuring attitudes. After the implementation stage was completed, it proceeded to the evaluation stage, which was the stage to determine whether the attitude instrument that had been developed was valid and reliable based on the score data obtained from the implementation stage. The results of the validity and reliability analysis of the attitude instrument for students in practical activities can be seen in Table 3 and 4.

Table 3. Results of Empirical Validity Test of Attitude Assessment Aspect Items

Item	r-count	r-table	Category
1	0.7801560468	0.3291	Valid
2	0.5437157549	0.3291	Valid
3	0.5437157549	0.3291	Valid
4	0.3319700011	0.3291	Valid
5	0.5532833352	0.3291	Valid
6	0.5437157549	0.3291	Valid
7	0.5437157549	0.3291	Valid
8	0.3333333333	0.3291	Valid

At a significance level of $\alpha=0.05$ with a sample size of $n=36$, the value of $r_{table}= 0.3291$ was obtained. Based on the analysis results, the calculated r coefficient (r_{xy}) for each item in the attitude assessment aspect showed a value greater than r_{table} . Thus, items 1 to 8 in the attitude assessment aspect were declared valid and usable. This validity indicates that the attitude assessment instrument is consistently capable of measuring what should be measured in practical activities on environmental pollution material.

Table 4. Reliability Test

Coefficient of Reliability	Interpretation
0,4222685	Sedang

Based on the results of reliability coefficient calculations using a sample of 36 people, a value of 0.4223 was obtained. This value indicates that the attitude assessment instrument has a sufficient level of reliability. This means that this instrument is capable of producing fairly consistent measurements when applied to students in comparable conditions. Thus, this instrument can be considered sufficiently reliable and dependable to support the process of assessing student attitudes effectively and can be relied upon to help teachers understand what aspects are being measured during environmental pollution practicum activities.

The findings of this study indicate that the developed attitude assessment instrument has a high level of validity and sufficient reliability, so that it can be used as a basis for biology practical activities in senior high schools with some further adjustments. From a pedagogical perspective, these results confirm that various aspects of students' scientific attitudes, such as curiosity, responsibility, discipline, and the ability to work together, can be measured objectively through observation instruments that are systematically compiled and adapted to the context of laboratory activities. Scientifically, this reinforces the view that affective domain assessment is not only a complement to the cognitive aspect but is an important part of the science learning process oriented towards the formation of scientific character. These findings also support the results of a study by Astalini et al., 2019, which concluded that the application of scientific attitude assessment instruments can increase students' awareness, participation, and involvement in experimental activities. Therefore, this study emphasises the role of attitude assessment as a strategic element in strengthening scientific character and developing affective assessment in biology education.

In practical terms, this study makes a real contribution to providing biology teachers with instruments for assessing students' scientific attitudes in a more focused, transparent manner that is appropriate to the context of practical-based learning. The implications of these findings highlight the importance of applying a more holistic assessment paradigm in schools, integrating the affective domain into every laboratory activity so that the science learning process emphasises not only knowledge acquisition but also the development of scientific attitudes and values. Further research is recommended to strengthen the reliability of the instrument through refinement of the statement items, revalidation by experts, and testing on a broader and more diverse population. In addition, teacher involvement in the readability testing stage will enrich the suitability and applicability of the instrument to actual learning conditions in the classroom. Thus, the results of this development are expected to be a stepping stone for the creation of a valid, reliable, and applicable

science assessment system in an effort to improve the quality of biology learning oriented towards the development of students' scientific attitudes.

This study has limitations that could potentially affect the interpretation of findings and the scope of generalisation. First, teachers were not involved in the readability testing process for students, thereby increasing the possibility of bias in understanding because the input of teachers, who have direct insight into the characteristics and behaviour of students, was not optimally utilised. Second, there were only 36 respondents from one class at SMAN 89 Jakarta. The relatively small sample size and the implementation of the study in only one school meant that the diversity of student backgrounds was not fully represented, so the results of the validity and reliability tests of the instrument should be considered as preliminary findings that require further verification. These conditions limit the ability of the research results to be generalised to a wider population, especially when applied to schools with different social, academic, or geographical contexts.

Furthermore, this study did not test construct validity using factor analysis approaches, either exploratory (EFA) or confirmatory (CFA), which play an important role in ensuring the statistical suitability of the relationship between indicators and attitude dimensions. Therefore, future research should involve teachers in readability testing, increase and vary the sample size, and add construct validity analysis so that the developed instrument has a stronger conceptual basis and reliability.

CONCLUSION AND RECOMENDATION

The results of this study show that the attitude assessment instrument developed has met the standards of validity and reliability suitable for use in biology practical activities at the secondary school level. Academically, these findings indicate that students' scientific attitudes can be evaluated objectively through observation instruments that are systematically compiled with reference to indicators appropriate to experimental activities. The development of this instrument also contributes conceptually to the development of affective assessment in science education, particularly by emphasising the relationship between scientific attitude indicators and the laboratory practice context as an authentic learning environment.

From an implementation perspective, this study offers an alternative assessment tool for biology teachers to measure students' scientific attitudes in a more focused, open, and contextual manner through practical activities. Further studies are recommended to improve the reliability of the instrument through refinement of the statement items, revalidation by experts, and application to a broader and more diverse population. In addition, teacher involvement in the readability testing process needs to be strengthened so that the instrument becomes more responsive to classroom conditions and student characteristics. With these steps, the developed instrument is expected to function consistently as a valid, reliable, and applicable assessment tool in supporting laboratory-based biology learning processes.

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