Effectiveness of Integrating Focused Listing Formative Assessment in Concept Attainment Models (CAM) Learning in Improving Concept Understanding of High School Stundents on Sound Waves Topic

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Abstract - *Conceptual understanding is an indicator of success in learning. One fundamental concept in physics that plays an important role is sound waves. However, observations, questionnaires, and interviews show that students' conceptual understanding is still low. This condition indicates the need for learning that not only helps students understand concepts but is also equipped with formative assessment to monitor conceptual understanding. One alternative that can be used is the integration of focused listing formative assessment in Concept Attainment Models (CAM) learning to improve students' conceptual understanding. The purpose of this study is to determine the effectiveness of integrating focused listing formative assessment techniques in Concept Attainment Models (CAM) learning in improving high school students' conceptual understanding of sound waves. The research method used is a quasi-experimental design with a nonequivalent control group design. The research sample involved 65 eleventh-grade students at a public high school in Garut Regency, divided into 35 students in the experimental class and 30 students in the control class. Data collection techniques in this study included concept comprehension tests, focused listing formative tests, and surveys in the form of questionnaires. The results of the study indicate that the integration of formative focused listing assessment techniques in CAM learning is effective in improving students' conceptual understanding of sound wave material, with an increase in conceptual understanding of 61.86% and an effect size of 0.709, which falls into the moderate category.*

Keywords*: Formative Assessment Focused Listing; Concept Attainment Models* (CAM)*; Conceptual Understanding.*

INTRODUCTION

Physics learning at the senior high school level aims to develop students' conceptual understanding in depth. One of the fundamental concepts in physics that has an important role is sound waves. This concept is closely related to various phenomena in everyday life such as musical instruments, and the Doppler effect on ambulance sirens (Halliday et al. 2005). Therefore, achieving conceptual understanding is an indicator of success in learning (S. Z. Dewi & Ibrahim, 2019).

However, the achievement of students' learning outcomes on sound waves at the senior high school level is not optimal. Based on the results of classroom observations, distributing questionnaires to students and interviews with physics educators at one of the Public High Schools in Bandung City conducted by researchers, it was found that students had difficulty in understanding the concept of sound waves. The results of the questionnaire given to students who have studied sound waves material also found that the main factors causing low understanding of concepts are low motivation to learn (43.3%), the tendency to memorize formulas without understanding concepts (59.7%), and the inability to solve problems independently (82.1%). The results of interviews with physics educators also confirm that the low understanding of the concept of students is

caused by a lack of motivation in learning physics, the amount of material that must be mastered, and the difficulty of students in solving physics problems. This aligns with the findings of Novitasari et al. (2024), which showed that 29.7% of students did not understand the concepts. Meanwhile, Nova et al. (2020) stated that the level of understanding of sound wave concepts was in the very low category for three indicators, namely explaining, interpreting, and applying.

Additionally, educators have implemented various learning models such as cooperative learning, Problem-Based Learning (PBL), and Project-Based Learning (PJBL). Although all three are theoretically effective when applied, preliminary study results indicate that students' conceptual understanding in schools is in the lower-middle category. As an alternative, Concept Attainment Models (CAM) have the advantage of systematically developing students' conceptual understanding through the process of classifying positive and negative examples (Kilbane & Milman, 2014). This learning model is more explicit in building concepts compared to PBL and PJBL, which focus on problem-solving and final products.

This situation highlights a gap between the ideal requirements of physics education, which emphasize deep conceptual understanding, and the reality on the ground, where students have not yet achieved optimal conceptual understanding competencies.

Assessment and learning are an inseparable unity (Kemdikbudristek, 2024). Assessment should be based on the learning objectives. Several studies on formative assessment in physics learning, such as those conducted by Yilmaz & Bulunuz (2019) and Bulunuz & Bulunuz (2017), indicate that formative assessment is proven effective in enhancing students' conceptual understanding. Additionally, research on the integration of formative assessment in learning conducted by A. P. Dewi et al. (2021) shows that formative feedback assessments can help learners understand a concept. Furthermore, research by Azizah et al. (2020) also suggested that the application of concept checks as a formative assessment technique proved effective.

However, until now no research has been found that specifically integrates the Concept Attainment Models (CAM) learning model with focused listing formative assessment techniques on sound waves material. Based on this, this research has an element of novelty, namely in the form of integration of focused listing formative assessment in Concept Attainment Models (CAM) learning in improving the concept understanding of high school students on sound waves material.

RESEARCH METHODS

Quantitative research method with a quasi-experimental design in the form of a nonequivalent control group design that refers to the pretest-posttest control group design pattern (Creswell & Creswell, 2018). The research design can be seen in Table 1.

Table 1. Research Design

Group (A) Eksperimental	O	X	O
Group (B) Control	O	–	O

(Creswell & Creswell, 2018)

Description:

O: Pretest and Posttest

X: Treatment for the experimental class was in the form of Concept Attainment Models (CAM) learning integrated with focused listing formative assessment.

$-$: Treatment for the control class in the form of Concept Attainment Models (CAM) learning without being integrated with focused listing formative assessment.

The study's population consisted of all grade 11 high school students in the Garut Regency during the even semester of the 2024–2025 academic year. The convenience sampling approach, which bases selection on student participation and ease of access, was used to choose the sample (Sugiyono, 2024). Because it is compatible with the field's conditions, this technique was selected. The convenience sampling technique's drawbacks, however, cannot be applied to the whole population because the sample does not include all of the high school students in the eleventh grade in Garut Regency.

Concept comprehension exams, formative focused listing tests, and surveys were employed as data collection methods. There were sixteen items on the concept comprehension test and eleven items on the formative focused listing test, which were based on concept comprehension indications. (Wiggins, G., & McTighe, 2005).

Before the concept comprehension test and formative focused listing test are used, these tests will be tested for feasibility using validity tests, reliability tests, difficulty levels, and discriminating power. The validation results for the concept comprehension test will be processed using Aiken's V method with the equation:

$$V = \frac{\Sigma(r - I_O)}{|n(c-1)|} \qquad (1)$$

Description:

V: Aiken validity index
r: Score given by validator
I_0: Lowest score on the assessment scale
n: Number of validators
c: Number of categories on the assessment scale

(Aiken, 1985)

The purpose of this process is to ask validators to assess the feasibility of a concept comprehension test instrument and a focused listing formative test that covers aspects of material, construction, and language in each item. The validity scale used for construct validity is a Likert scale ranging from 1 to 5, with the following descriptions: 1 = not relevant at all, 2 = not relevant, 3 = somewhat relevant, 4 = relevant, 5 = very relevant. After obtaining the Aiken validity score for each item according to its assessment aspect, the researcher makes a decision regarding the suitability of each item based on the reference values in Aiken's V table. In this construct validity test, a five-point rating scale involving five experts is used, so the minimum validity index score is 0.80.

Formative focused listing tests were conducted three times during the learning process. The first meeting consisted of four questions covering the sub-concepts of sound waves and sound wave velocity. The second meeting consisted of three questions covering the sub-topic of sound sources. The third meeting consisted of four questions covering the sub-topics of the Doppler effect, sound propagation, and sound intensity levels.

No	*Concept Focus*	*Listing*
1	Sebutkan dan jelaskan dua konsep terkait gelombang bunyi!	1. 2.
2	Gelombang bunyi memerlukan medium untuk merambat. Sebutkan dan jelaskan medium perambatan pada gelombang bunyi!	1. 2. 3.
3	Perhatikan tabel di bawah ini! **Medium Perambatan** / **Kecepatan Perambatan Bunyi** Udara (0°) — 331 Air — 1490 Besi — 5130 Berdasarkan tabel di atas, sebutkan dan jelaskan faktor yang memengaruhi cepat rambat gelombang bunyi!	1. 2. 3. 4.

Figure 1. Example of a Formative Assessment Focused Listing on The Sub-Topic of Sound Waves and The Speed of Sound Waves.

Figure 1 shows the formative assessment focused listing in the first meeting with the sub-material of introductory sound waves and sound wave velocity. Then, a preparatory test comprising the normality and homogeneity tests was conducted to determine the increase in concept knowledge of sound wave content in the experimental class. The difference between the pre- and post-test scores was then assessed using a paired sample t-test, and the increase in concept understanding was gauged using the N-Gain test. Additionally, posttest results in both classes were compared using the independent sample t-test. Additionally, the influence of treatment on both classes is assessed using the effect size test.

RESULTS AND DISCUSSION

Result

The experimental class's pretest and posttest results were examined utilizing a preparatory test that included a normalcy test in order to ascertain the rise in conceptual knowledge following the incorporation of focused listing formative evaluation.

Table 2. Normalistas Test of Conceptual Understanding in the Experimental Class

	Statistic	df	Sig.
Pretest	0.947	35	0.092
Posttest	0.948	35	0.098

According to the preceding table, the data is regularly distributed because the sig. values are 0.092 and 0.098. To ascertain the difference between the experimental class's pretest and posttest scores, a paired sample t-test is the next step.

Table 3. Paired Sample t-test for Concept Understanding Test in Experimental Class

	Mean	Std. Deviation	Sig.
Pretest Posttest	-42.257	18.171	0.000

The results of the pretest and posttest data analysis in the experimental class obtained a Sig. of 0.000, because the sig. value was < 0.05. This shows that there was a significant difference between the pretest and posttest scores in the students' understanding of the concept after participating in the learning process. Then, to determine the increase in understanding of the concept in the experimental class.

Table 4. N-Gain Test to Determine Conceptual Understanding Improvement in Experimental Classes

	Mean	Std. Deviation
N-Gain Score	.6186	.19135
N-Gain Percen	.61.8551	19.1354

The results of pretest and posttest data processing in the experimental class showed an increase in N-Gain score of 0.6186 and N-Gain percentage of 61.8551 in the moderate category.

In addition, the researcher analyzed the increase in N-Gain for each aspect of concept understanding before (pretest) and after (posttest) the implementation of CAM learning integrated with focused listing formative assessment.

Table 5. Improvement in Each Aspect for the Experimental Class before (pretest) and after (posttest)

Aspects	Pretest	Posttest
Explanation	55.2	94.3
Interpretation	18.6	84.3
Application	30.4	69.4

Meanwhile, in the control class, there was an increase in

Table 6. Improvement in Each Aspect for the Control Class before (pretest) and after (posttest)

Aspects	Pretest	Posttest
Explanation	47.8	90.0
Interpretation	11.5	75.6
Application	25.2	61.8

Based on the table above, the most significant improvement was in the aspect of

explaining in the experimental class. This can be explained by the characteristics of the learning model used. The CAM model is specifically designed to train students to observe positive and negative examples in order to identify and explain the differences between concepts. A high increase in scores was also obtained in the interpretation aspect, particularly in the experimental class. This was influenced by the use of focused listing formative assessment, which helped students to reorganize the list of important concepts that had been learned during the learning process. Meanwhile, the increase in the application aspect was moderate when compared to the two previous aspects, namely explanation and interpretation.

In addition, the researcher conducted an N-Gain increase analysis for each aspect in both classes.

Table 7. Increase in N-Gain for each aspect in the Experiment class

Aspects	N-Gain	Description
Explanation	0.87	High
Interpretation	0.81	High
Application	0.56	Medium

Meanwhile, for the control class

Table 8. Increase in N-Gain for each aspect in the control class

Aspects	N-Gain	Description
Explanation	0.81	High
Interpretation	0.72	High
Application	0.49	Medium

In the experimental class, the greatest improvement in understanding was 0.87 with a high category, followed by interpretation with 0.81 with a high category and application with 0.56 with a moderate category, according to the N-Gain analysis results.

Additionally, posttest data analysis was carried out on the experimental class and control class utilizing prerequisite tests, specifically the normality and homogeneity tests, in order to ascertain the degree of efficacy of the integration of focused listing formative assessment.

Table 9. Normal Test

	Statistic	df	Sig.
Pretest	0.948	35	0.098
Posttest	0.942	35	0.100

A significant value of 0.098 was obtained for the experimental class's posttest and 0.100 for the control class's posttest, respectively, based on the findings of the Shapiro-Wilk normality test. Since the significance values in both classes are higher than >0.05, it can be said that the posttest results in both classes follow a normal distribution.

Table 10. Homogeneity Test

	Levene Statistic	Sig.
Mean	0.948	0.771

Based on the Levene test results on the posttest scores of students' conceptual comprehension for both classes, the average calculation yielded a Levene value of 0.085 with a significance level of 0.771. It can be said that the data has homogeneous variance because the significance value (sig.>0.05) is higher than 0.05. Thus, the homogeneity assumption is satisfied.

Table 11. Independent sample t-test in the experimental class and control class

	Mean	t	Sig. (2-tailed)
Eksperimental Group Posttest	76.00	2.850	0.006
Control Group Posttest	68.43		

Then, an independent sample t-test was utilized to find out how focused listing formative assessment improved students' comprehension of sound wave concepts.

Based on the table, a significance value of 0.006 was obtained, which is smaller than the significance limit of 0.05.

This indicates that there is a significant difference between the posttest results of the students' understanding of the concept in the experimental class and the control class.

Therefore, to determine the magnitude of the effect of the treatment in the experimental class compared to the control class, an effect size test was conducted.

Table 12. Effect Size Test

	Value	Category
Cohen's d	0.709	Medium

A moderate value of 0.709 was achieved based on the effect size test. To discover more about how students reacted to the use of focused listing formative evaluation in Concept Attainment Models (CAM) learning, the researcher also created a questionnaire. Four categories—attention, relevance, confidence, and satisfaction—were used to group the students' questionnaire answers. The percentage of students who answered the inquiry about the incorporation of formative assessment-focused listing in Concept Attainment Models (CAM) learning is summarized below.

Table 13. Summary of Student Responses to the Integration of Formative Assessment Focused Listing in CAM Learning

Indicator	Percentage (%)	Categori
Attention	78.28	Good
Relevance	86.00	
Self-confidence	74,14	
Satisfaction	81.14	
Average	79.89	

Based on the table above, it is known that the integration of focused listing formative assessment in Concept Attainment Models (CAM) learning received positive responses from students. In terms of attention, an average percentage of 78.28% was obtained, which is categorized as good. This shows that students feel that physics learning has become more interesting and helpful in identifying core concepts through focused listing formative assessment. In terms of relevance, the average percentage reached 86.00% with a very good category. This percentage shows that students consider focused listing formative assessment relevant in helping them understand important concepts and relate them to real life in the material on sound waves. Meanwhile, in terms of confidence, the average percentage was 74.14% with a good category. These results indicate that most students feel motivated and confident in learning sound wave material because they are assisted by focused listing formative assessment. In terms of satisfaction, the average percentage was 81.14%, which is categorized as very good. This percentage shows that students are satisfied with the integration of formative assessment focused listing because it helps them understand concepts well and feel more active in the learning process.

Discussion

Focused listing is a formative assessment technique that focuses learners on representing the results of their work in a single term, name, or important concept in a learning activity that directs learners to make several lists of ideas related to the "focus point" (Angelo & Cross, 1993). Meanwhile, Concept Attainment Models (CAM) are learning models designed to enhance students' conceptual understanding. These models are structured with interactive learning stages that present examples related to the concept alongside examples unrelated to the concept (Kilbane and Milman 2014).

A significance of 0.000, or less than 0.05, was determined by the statistical analysis of the paired sample t-test results. This suggests that the experimental class's pretest and posttest results differed

significantly. In both the experimental and control courses, the incorporation of focused listing formative assessment in CAM learning has boosted students' concept understanding between before (pretest) and after (posttest). The N-Gain value attained was 0.1686, with a percentage of 61.88%.

In terms of conceptual understanding, namely explaining and interpreting, both classes showed a high increase, while in terms of applying, both classes were in the moderate category when compared to the two previous aspects, namely explaining and interpreting. The ability to apply requires students to use knowledge and skills in new situations, both authentically and realistically (Wiggins, G., & McTighe 2005). Meanwhile, in Bloom's taxonomy revised by (Anderson & Krathwohl (2001) the ability to apply occupies a high level of thinking. Therefore, it requires more intensive time and practice.

Therefore, it can be said that students' conceptual understanding is much enhanced when formative assessment-focused listing is incorporated into Concept Attainment Models (CAM) learning. According to study by Kumar & Mathur (2013), students' comprehension of physics ideas can be enhanced via Concept Attainment Models (CAM). Sari et al. (2019), who found that including formative evaluation into instruction significantly improves students' conceptual knowledge, further supports this finding. Furthermore, formative evaluation has been shown to be successful in enhancing students' conceptual comprehension, according to research by (Yilmaz & Bulunuz, 2019).

Additionally, a significant value of 0.006 was achieved based on the independent sample t-test results, which is less than the significance criterion of 0.05. This suggests that students' conceptual comprehension posttest scores in the experimental class and the control class differ significantly. The effect size computation also produced a Cohen's d value of 0.709. According to this value, high school students' conceptual comprehension is moderately improved when focused listing formative evaluation is incorporated into Concept Attainment Models (CAM) instruction. This is consistent with the findings of Ifrianti et al.'s (2019) study, which indicates that the use of Concept Attainment Models (CAM) significantly improves students' conceptual understanding. Sari et al. (2019), who claimed that the incorporation of formative evaluation into instruction had a major impact on students' conceptual understanding, further supports this finding. Additionally, Bulunuz and Bulunuz's (2017) research shows that formative evaluation can greatly enhance students' conceptual comprehension.

The formative assessment focused listing used in this study was a list of questions that had been adjusted to the indicators. The purpose of this formative assessment was to determine the extent to which students understood the important concepts that had been learned during the learning process. The formative assessment focused listing was conducted by asking students to write down a list of core concepts that they understood related to the material being studied.

The results of the assessment are then reviewed and analyzed by the educator to evaluate the accuracy and completeness of the concepts written by the students. The educator then provides feedback in the form of written comments. In addition, considering the time required to conduct the assessment, educators also provide verbal feedback. This is in line with (Black & Wiliam, 1998), who argue that formative assessment is a continuous process used by

educators to gather information about student learning, provide feedback, and adjust learning strategies to suit student needs.

Based on Table 8, the overall average response of students to the focused listing formative assessment in the Concept Attainment Models (CAM) learning, which covers four aspects, namely attention, relevance, self-confidence, and satisfaction, obtained an average percentage of 79.89% and was categorized as good. This is in line with Ramdhani et al. (2024), who stated that formative assessment helps students improve their learning motivation and conceptual understanding abilities.

CONCLUSION

According to the findings of statistical analysis using a paired sample t-test 0.000<0.05, there was a difference in the experimental class's comprehension of the concept before and after the integrated formative assessment focused listing in Concept Attainment Models (CAM) learning. The moderate category's N-Gain test result was 61.86%. With a moderate effect size of 0.709, the independent sample t-test revealed a significant difference between the experimental class's and the control class's posttest scores (p-value of 0.006 < 0.05).

Thus, the findings of this study demonstrate that the use of focused lists formative assessment is successful in enhancing conceptual comprehension of the content related to sound waves. Students' attention, relevance, self-confidence, and happiness all improved when focused listing formative assessment was incorporated into Concept Attainment Model (CAM) learning. Their average score was 79.89%, which is considered good. Applying the focused listing formative assessment technique to conceptual physics content or incorporating it into other learning models is advised.

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