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# *Field Testing a Research-Based Enrichment Module to Improve Students' Cognitive Learning Outcomes in Biodiversity*

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***Abstract***

The research-based enrichment module is a teaching material designed from recent studies and aligned with relevant learning content. This module aims to enrich students' knowledge, improve their critical thinking skills, and enhance their understanding of current scientific concepts. This study investigated the effectiveness of a research-based enrichment module on karamunting plant identification in improving students' learning outcomes. An experimental design with a pretest-posttest control group was applied. The population included 157 Grade X students at SMK Pertanian Pembangunan Negeri Sembawa. Using cluster sampling, 30 students from Grade X ATP 1 (control) and 30 from Grade X ATP 2 (experimental) were selected. The experimental group used the enrichment module, while the control group did not use any additional learning materials. Data were collected through cognitive learning outcome tests and analysed using descriptive statistics and a paired sample t-test. Results showed the experimental group achieved a mean post-test score of 81.67, compared to 70.50 in the control group. The paired sample t-test indicated a significant effect ($p = 0.000$, $p < 0.05$). Thus, the enrichment module on karamunting identification significantly improved students' cognitive learning outcomes.

**Keywords:** *Biodiversity; Enrichment Module; Learning Outcomes; ResearchBased*

## INTRODUCTION

Education is a conscious effort to assist and direct students in the teaching and learning process to maximise their human resource potential. Education, which takes place through direct interaction between teachers and students, is vital to human existence. Face-to-face learning activities in schools facilitate this interaction. Enhancing students' cognitive experiences and realising real and practical quality improvements are essential aspects of education. One way to achieve these deliberate and planned efforts is through developing effective learning media. The media serves as a tool that can be used to deliver information to learners (A. P. Wulandari et al., 2023).

According to (Firmadani, 2020; Harahap & Solihin, 2025) learning media are supporting tools educators use to deliver material, stimulate students' creativity, and improve their focus during the teaching and learning process. Appropriate learning media can create an atmosphere that enhances students' determination to learn. Learning innovations continue to develop to improve the quality of education, one of which is the use of research-based enrichment modules. A research-based enrichment module is teaching material designed based on recent research findings that are aligned with the curriculum. The use of this module can sharpen students' reasoning abilities (Fitriyah, 2020; Nasution & Al-Amin, 2025; Harahap et al., 2020).

In the Indonesian context, research-based enrichment modules have not yet been fully optimised. Although several schools and higher education institutions have begun adopting this approach, many educational institutions have not maximised its potential. Therefore, further research on the effectiveness of research-based enrichment modules in Indonesian education is crucial. In this study, further research will be conducted as a field test on using a research-based enrichment module. The module to be field-tested was previously developed by Aulia (2024), titled "Development of a Research-Based Enrichment Module for the Identification of Karamunting Plants *(Rhodomyrtus tomentosa)* in Grade X." In the previous study, this module was declared valid and practical.

The earlier research conducted at SMA Negeri 19 Palembang involved a practicality test, but the module's effectiveness in learning has not yet been examined. According to educational practitioners, the enrichment module Aulia (2024) developed meets the established competency standards and contains appropriate learning indicators. The materials presented in the module also enrich students' knowledge and understanding of biodiversity, particularly concerning *Rhodomyrtus tomentosa* (Karamunting plants). However, a limitation of the previous study was that the Tessmer development model was used during the development and validation stages, but only up to the one-to-one/small group stage due to time and budget constraints. Tessmer's model consists of five stages: preliminary, self-evaluation, expert reviews, one-to-one/small group, and field testing. Therefore, this study aims to continue the previous research by implementing the final stage, the field test, to evaluate the module's effectiveness in real classroom settings.

## RESEARCH METHODS

This study will employ a quantitative research design. The research methodology used is a Quasi-Experimental Design. This study involves one independent variable, the

enrichment module (variable X), and one dependent variable, students' cognitive abilities (variable Y). The research design applied is the Pretest-Posttest Control Group Design, which involves two selected classes. The optimal pretest and posttest results indicate a significant score difference (Niswara et al., 2019).

**Table 1.** ***Pre-test Post-test Control Group Design***

| Group | Pre-test | Perlakuan | *Post-test* |
|---|---|---|---|
| Experiment | $Y_1$ | $X_1$ | $Y_2$ |
| Control | $Y_3$ | $X_2$ | $Y_4$ |

The population in this study consisted of all Grade X students at SMK PP Negeri Sembawa in the 2024–2025 academic year. The sampling method used was cluster sampling combined with probability sampling. Data collection techniques included field studies, literature studies, and tests. The research instrument consisted of pre-test and post-test questions in multiple-choice items to assess students' cognitive learning outcomes. Subject matter experts validated these test items and underwent validity testing, reliability testing, and item analysis. Furthermore, data analysis techniques employed descriptive and inferential statistics, including calculation of mean scores, normality tests, homogeneity tests, hypothesis testing, and N-Gain score analysis.

## RESULTS AND DISCUSSION

The validity test determined whether the questions were valid by evaluating the test items with 32 students who had previously studied the biodiversity material. The testing criteria stated that if rcount > rtable at a = 0.05, the question was considered valid; whereas if rcount < rtable, the question was deemed invalid. The validity test was calculated using SPSS version 26. The following are the findings from the validity test of the questions.

**Table 2** ***Item Validity Test Results***

| Item(s) | Cognitive Lv | Computed r | Tabel r | Noted | Category |
|---|---|---|---|---|---|
| Item 1 | C1 | 0,569 | 0,349 | Valid | Fair |
| Item 2 | C1 | 0,083 | 0,349 | Invalid | Very Low |
| Item 3 | C1 | 0,340 | 0,349 | Invalid | Low |
| Item 4 | C1 | 0,706 | 0,349 | valid | High |
| Item 5 | C2 | 0,551 | 0,349 | valid | Fair |
| Item 6 | C3 | 0,765 | 0,349 | valid | High |
| Item 7 | C2 | 0,516 | 0,349 | valid | Fair |
| Item 8 | C2 | 0,169 | 0,349 | valid | Very Low |

| Item(s) | Cognitive Lv | Computed r | Tabel r | Noted | Category |
|---|---|---|---|---|---|
| Item 9 | C2 | 0,103 | 0,349 | Invalid | Very Low |
| Item 10 | C1 | 0,630 | 0,349 | valid | High |
| Item 11 | C1 | -0,181 | 0,349 | Invalid | Very Low |
| Item 12 | C2 | 0,697 | 0,349 | valid | High |
| Item 13 | C3 | 0,269 | 0,349 | Invalid | Low |
| Item 14 | C1 | 0,656 | 0,349 | valid | High |
| Item 15 | C3 | 0,079 | 0,349 | Invalid | Very Low |
| Item 16 | C4 | 0,446 | 0,349 | valid | Fair |
| Item 17 | C5 | 0,189 | 0,349 | Invalid | Very Low |
| Item 18 | C6 | 0,127 | 0,349 | Invalid | Very Low |
| Item 19 | C6 | 0,718 | 0,349 | valid | High |
| Item 20 | C5 | 0,058 | 0,349 | Invalid | Very Low |
| Item 21 | C5 | 0,612 | 0,349 | valid | High |
| Item 22 | C6 | 0,718 | 0,349 | valid | High |
| Item 23 | C6 | 0,602 | 0,349 | valid | High |
| Item 24 | C5 | -0,189 | 0,349 | Invalid | Very Low |
| Item 25 | C6 | 0,407 | 0,349 | Valid | Fair |
| Item 26 | C4 | 0,001 | 0,349 | Invalid | Very Low |
| Item 27 | C1 | 0,264 | 0,349 | Invalid | Low |
| Item 28 | C1 | 0,141 | 0,344 | Invalid | Very Low |
| Item 29 | C2 | 0,057 | 0,349 | Invalid | Very Low |
| Item 30 | C3 | 0,184 | 0,349 | Invalid | Very Low |
| Item 31 | C1 | 0,364 | 0,349 | Valid | Low |
| Item 32 | C2 | 0,219 | 0,349 | Invalid | Low |
| Item 33 | C2 | 0,242 | 0,349 | Invalid | Low |
| Item 34 | C1 | 0,225 | 0,349 | Invalid | Low |
| Item 35 | C1 | 0,230 | 0,349 | Invalid | Low |
| Item 36 | C2 | 0,219 | 0,349 | Invalid | Low |
| Item 37 | C1 | 0,429 | 0,349 | Valid | Fair |
| Item 38 | C3 | 0,403 | 0,349 | valid | Fair |
| Item 39 | C1 | 0,269 | 0,349 | Invalid | Low |
| Item 40 | C3 | 0,233 | 0,349 | Invalid | Low |
| Item 41 | C2 | 0,054 | 0,349 | Invalid | Very Low |
| Item 42 | C2 | 0,531 | 0,349 | valid | Fair |
| Item 43 | C4 | 0,462 | 0,349 | valid | Fair |
| Item 44 | C4 | 0,325 | 0,349 | Invalid | Low |
| Item 45 | C3 | 0,207 | 0,349 | Invalid | Low |
| Item 46 | C3 | 0,143 | 0,349 | Invalid | Very Low |
| Item 47 | C3 | 0,199 | 0,349 | Invalid | Very Low |
| Item 48 | C3 | 0,529 | 0,349 | valid | Fair |
| Item 49 | C3 | -0,028 | 0,349 | Invalid | Very Low |
| Item 50 | C3 | 0,217 | 0,349 | Invalid | Low |

Based on the table above, it can be seen that Item 1 obtained an r hitung value of 0.569, Item 2 obtained an r hitung value of 0.083, and Item 3 obtained an r hitung value of

0.340. If the value is positive and r hitung > r tabel, the item is considered valid; if r count < r table, the item is considered invalid.

**Table 3.** ***Reliability Statistic***

| Cronbach's Alpha | N of Items |
|---|---|
| 0,713 | 51 |

The table above shows that a reliability coefficient 0.713 was obtained with a significance level of α = 0.05. This indicates that the test instrument is considered reliable with a high category and can, therefore, be used in the study.

**Table 4.** ***Analysis of Item Discrimination and Item Difficulty***

| No | N | D | Chategory | P | Chategory | Validity | Noted |
|---|---|---|---|---|---|---|---|
| 1 | 32 | 0,437 | Good | 0,656 | Medium | Valid | Retained |
| 2 | 32 | 0,062 | Kurang | 0,781 | Easy | Invalid | Discarded |
| 3 | 32 | 0,312 | Fair | 0,343 | Medium | Invalid | Discarded |
| 4 | 32 | 0,812 | Very Good | 0,468 | Medium | Valid | Retained |
| 5 | 32 | 0,437 | Good | 0,656 | Easy | Valid | Retained |
| 6 | 32 | 0,562 | Good | 0,593 | Medium | Valid | Retained |
| 7 | 32 | 0,437 | Good | 0,656 | Easy | Valid | Retained |
| 8 | 32 | 0,125 | Kurang | 0,875 | Easy | Invalid | Discarded |
| 9 | 32 | -0,063 | Kurang | 0,781 | Easy | Invalid | Discarded |
| 10 | 32 | 0,437 | Good | 0,781 | Easy | Valid | Retained |
| 11 | 32 | -0,125 | Kurang | 0,687 | Medium | Invalid | Discarded |
| 12 | 32 | 0,437 | Good | 0,468 | Medium | Valid | Retained |
| 13 | 32 | 0,062 | Kurang | 0,656 | Medium | Invalid | Discarded |
| 14 | 32 | 0,750 | Very Good | 0,375 | Difficult | Valid | Retained |
| 15 | 32 | 0 | Kurang | 0,625 | Medium | Invalid | Discarded |
| 16 | 32 | 0,437 | Good | 0,468 | Medium | Valid | Retained |
| 17 | 32 | 0,125 | Kurang | 0,687 | Easy | Invalid | Discarded |
| 18 | 32 | 0,062 | Kurang | 0,468 | Medium | Invalid | Discarded |
| 19 | 32 | 0,500 | Good | 0,250 | Difficult | Valid | Retained |
| 20 | 32 | -0,063 | Kurang | 0,656 | Medium | Invalid | Discarded |
| 21 | 32 | 0,562 | Good | 0,281 | Difficult | Valid | Retained |
| 22 | 32 | 0,500 | Good | 0,250 | Difficult | Valid | Retained |
| 23 | 32 | 0,312 | Fair | 0,281 | Difficult | Valid | Retained |
| 24 | 32 | -0,188 | Kurang | 0,656 | Easy | Invalid | Discarded |
| 25 | 32 | 0,562 | Good | 0,281 | Difficult | Valid | Retained |
| 26 | 32 | -0,062 | Kurang | 0,468 | Medium | Invalid | Discarded |
| 27 | 32 | 0,250 | Fair | 0,500 | Medium | Invalid | Discarded |
| 28 | 32 | 0,125 | Kurang | 0,437 | Medium | Invalid | Discarded |
| 29 | 32 | 0,062 | Kurang | 0,593 | Medium | Invalid | Discarded |
| 30 | 32 | 0,312 | Fair | 0,531 | Medium | Invalid | Discarded |
| 31 | 32 | 0,312 | Fair | 0,593 | Medium | Valid | Retained |
| 32 | 32 | 0,187 | Kurang | 0,466 | Medium | Invalid | Discarded |
| 33 | 32 | 0,062 | Kurang | 0,343 | Medium | Invalid | Discarded |
| 34 | 32 | 0,187 | Kurang | 0,343 | Medium | Invalid | Discarded |
| 35 | 32 | 0,187 | Kurang | 0,281 | Difficult | Invalid | Discarded |

| No | N | D | Chategory | P | Chategory | Validity | Noted |
|---|---|---|---|---|---|---|---|
| 36 | 32 | 0,312 | Fair | 0,593 | Medium | Invalid | Discarded |
| 37 | 32 | 0,437 | Good | 0,468 | Medium | Valid | Retained |
| 38 | 32 | 0,437 | Good | 0,468 | Medium | Valid | Retained |
| 39 | 32 | 0,312 | Fair | 0,468 | Medium | Invalid | Discarded |
| 40 | 32 | 0,187 | Kurang | 0,343 | Medium | Invalid | Discarded |
| 41 | 32 | 0 | Kurang | 0,500 | Medium | Invalid | Discarded |
| 42 | 32 | 0,562 | Good | 0,406 | Medium | Valid | Retained |
| 43 | 32 | 0,312 | Fair | 0,468 | Medium | Valid | Retained |
| 44 | 32 | 0,125 | Kurang | 0,687 | Medium | Invalid | Discarded |
| 45 | 32 | 0,187 | Kurang | 0,406 | Medium | Invalid | Discarded |
| 46 | 32 | 0,062 | Kurang | 0,593 | Medium | Invalid | Discarded |
| 47 | 32 | 0,187 | Kurang | 0,406 | Medium | Invalid | Discarded |
| 48 | 32 | 0,375 | Fair | 0,437 | Medium | Valid | Retained |
| 49 | 32 | 0 | Kurang | 0,437 | Medium | Invalid | Discarded |
| 50 | 32 | -0,063 | Kurang | 0,716 | Easy | Invalid | Discarded |

Table 4 presents the discrimination and difficulty level analysis results for this study's pretest and posttest questions. The calculations showed that 14 items were classified as "good," 2 items as "very good," 9 items as "fair," and 25 items as "poor." Regarding the difficulty level, seven items were categorised as "difficult," 34 items as "moderate," and nine items as "easy." Based on these results, it can be concluded that 20 out of the 50 test items met the difficulty level criteria and are suitable for use in the study.

The cognitive learning outcome data on biodiversity for Grade X students were collected from the research conducted at SMK PP Negeri Sembawa. The results are presented as follows:

**Table 5.** ***Results of Normality Test of Students' Learning Outcomes Data***

| Test of Normality | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Shapiro Wilk | | | | | |
| | Group | Statistic | df | Sig. | Statistic | df | Sig. |
| Hasil | Control Pretest | 0,198 | 30 | 0,004 | 0,934 | 30 | 0,063 |
| | Control Posttest | 0,121 | 30 | 0,200 | 0,954 | 30 | 0,222 |
| | Experiment Pretest | 0,164 | 30 | 0,039 | 0,935 | 30 | 0,068 |
| | Experiment Posttest | 0,180 | 30 | 0,015 | 0,942 | 30 | 0,104 |

Based on the Shapiro-Wilk analysis above, the significance value for the control class pretest was 0.063, and for the experimental class pretest, it was 0.068. Meanwhile, the significance value for the control class posttest was 0.222, and for the experimental class posttest, it was 0.104. Since all significance values are greater than 0.05, this indicates that the data are typically distributed.

**Table 6. *Homogeneity Test Results***

| Test Of Homogenity of Variance | | | | | |
|---|---|---|---|---|---|
| | | Levene Statistic | df1 | df2 | Sig. |
| Result | Based on Mean | 0,131 | 1 | 58 | 0,718 |
| | Based on Median | 0,123 | 1 | 58 | 0,727 |
| | Based on Median and with adjusted df | 0,123 | 1 | 57.212 | 0,727 |
| | Based on the trimmed mean | 0,157 | 1 | 58 | 0,693 |

Table 6 above shows a significance value of 0.718, greater than 0.05. Thus, it can be concluded that the experimental class and the control class have equal variances.

**Table 7. Descriptive Statistic**

| Group Statistic | | | | | |
|---|---|---|---|---|---|
| Group | | N | Mean | Std. Deviation | Std. Error Mean |
| Result | Experiment | 30 | 81,67 | 8,644 | 1,578 |
| | Control | 30 | 70,50 | 9,591 | 1,751 |

Based on the descriptive analysis results, the mean score of the experimental class was 81.67, while the control class had a mean score of 70.50. The average score of students in the class that used the research-based enrichment module during the learning activities was higher. Thus, it can be concluded that using the research-based enrichment module to identify Karamunting plants has a significant effect on students' cognitive learning outcomes in the biodiversity subject for Grade X at SMK PP Negeri Sembawa.

**Table 8. *The Paired Samples t-Test***

| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Paired Differences | | | | | | | | | |
| 95% Confidence Interval of the Difference | | | | | | | | | |
| | | Mean | Std. Deviation | Std. Error Mean | Lower | upper | t | df | Sig.2-tailed) |
| Pair 1 | Pretest-posttest | -33,167 | 12,281 | 1,585 | -36,339 | -29,994 | -20,919 | 59 | 0,000 |

Based on the table above, the significance value (2-tailed) is 0.000, where 0.000 < 0.05, as shown in the previous table. Therefore, it can be stated that Ha is accepted and Ho is rejected. Ha: The research-based enrichment module on identifying Karamunting plants in

biodiversity material effectively improves students' cognitive learning outcomes. In this study, which employed a pretest-posttest control group design, the N-Gain Score test was used to evaluate the difference between pretest and posttest scores.

**Table 9. Result of N-Gain Pretest and Post-test Control Class**

| No | Pretest | Post test | Gain score from pretest to posttest | Ideal Score | N-gain _Score | Category |
|---|---|---|---|---|---|---|
| 1. | 40 | 75 | 35,00 | 60,00 | 58 | Medium |
| 2. | 55 | 75 | 30,00 | 45,00 | 67 | Medium |
| 3. | 35 | 85 | 40,00 | 65,00 | 62 | Medium |
| 4. | 30 | 75 | 45,00 | 70,00 | 64 | Medium |
| 5. | 50 | 70 | 20,00 | 50,00 | 40 | Medium |
| 6. | 40 | 85 | 45,00 | 60,00 | 75 | High |
| 7. | 40 | 65 | 25,00 | 60,00 | 42 | Medium |
| 8. | 50 | 85 | 35,00 | 50,00 | 70 | High |
| 9. | 45 | 70 | 25,00 | 55,00 | 45 | Medium |
| 10. | 40 | 60 | 20,00 | 60,00 | 33 | Low |
| 11. | 35 | 70 | 35,00 | 65,00 | 54 | Medium |
| 12. | 50 | 65 | 15,00 | 50,00 | 30 | Low |
| 13. | 50 | 80 | 30,00 | 50,00 | 60 | Medium |
| 14. | 45 | 65 | 20,00 | 55,00 | 36 | Low |
| 15. | 55 | 65 | 10,00 | 45,00 | 22 | Low |
| 16. | 40 | 55 | 15,00 | 60,00 | 25 | Low |
| 17. | 35 | 65 | 30,00 | 65,00 | 46 | Medium |
| 18. | 40 | 50 | 10,00 | 60,00 | 17 | Low |
| 19. | 45 | 55 | 10,00 | 55,00 | 18 | Low |
| 20. | 45 | 80 | 35,00 | 55,00 | 64 | Medium |
| 21. | 45 | 80 | 35,00 | 55,00 | 64 | Medium |
| 22. | 45 | 75 | 30,00 | 55,00 | 55 | Medium |
| 23. | 35 | 60 | 25,00 | 65,00 | 38 | Low |
| 24. | 55 | 70 | 15,00 | 45,00 | 33 | Low |
| 25. | 45 | 70 | 25,00 | 55,00 | 45 | Medium |
| 26. | 50 | 60 | 10,00 | 50,00 | 20 | Low |
| 27. | 45 | 85 | 40,00 | 55,00 | 73 | High |
| 28. | 50 | 80 | 30,00 | 50,00 | 60 | Medium |
| 29. | 50 | 70 | 20,00 | 50,00 | 40 | Medium |
| 30. | 50 | 70 | 20,00 | 50,00 | 40 | Medium |

**Table 10.** ***N-Gain Analysis Results of Pretest and Posttest in the Control Class***

| No | Pretest | Post test | Gain score from pretest to posttest | Ideal Score | Ngain _Score | Category |
|---|---|---|---|---|---|---|
| 1. | 35 | 80 | 45,00 | 65,00 | 69 | Medium |
| 2. | 35 | 60 | 25,00 | 65,00 | 38 | Low |
| 3. | 40 | 75 | 35,00 | 60,00 | 58 | Medium |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4. | 55 | 75 | 20,00 | 45,00 | 44 | Medium |
| 5. | 45 | 70 | 25,00 | 55,00 | 45 | Medium |
| 6. | 45 | 75 | 30,00 | 55,00 | 55 | Medium |
| 7. | 50 | 95 | 45,00 | 50,00 | 90 | High |
| 8. | 40 | 85 | 45,00 | 60,00 | 75 | High |
| 9. | 40 | 75 | 35,00 | 60,00 | 58 | Medium |
| 10. | 40 | 85 | 45,00 | 60,00 | 75 | High |
| 11. | 40 | 90 | 50,00 | 60,00 | 83 | High |
| 12. | 40 | 90 | 50,00 | 60,00 | 83 | High |
| 13. | 45 | 80 | 35,00 | 55,00 | 64 | Medium |
| 14. | 40 | 75 | 35,00 | 60,00 | 58 | Medium |
| 15. | 45 | 85 | 40,00 | 55,00 | 73 | High |
| 16. | 40 | 85 | 45,00 | 60,00 | 75 | High |
| 17. | 40 | 90 | 50,00 | 60,00 | 83 | High |
| 18. | 25 | 75 | 60,00 | 75,00 | 80 | High |
| 19. | 45 | 90 | 45,00 | 55,00 | 82 | High |
| 20. | 45 | 75 | 30,00 | 55,00 | 55 | Medium |
| 21. | 45 | 90 | 45,00 | 75,00 | 82 | High |
| 22. | 25 | 80 | 55,00 | 45,00 | 73 | High |
| 23. | 55 | 100 | 45,00 | 60,00 | 1.00 | High |
| 24. | 40 | 75 | 35,00 | 50,00 | 58 | Low |
| 25. | 50 | 95 | 45,00 | 50,00 | 90 | High |
| 26. | 30 | 80 | 50,00 | 70,00 | 71 | High |
| 27. | 45 | 75 | 30,00 | 55,00 | 55 | Medium |
| 28. | 30 | 75 | 45,00 | 70,00 | 64 | Medium |
| 29. | 35 | 75 | 40,00 | 65,00 | 62 | Medium |
| 30. | 55 | 85 | 30,00 | 45,00 | 67 | Medium |

The experimental class included 15 students in the high category, compared to 3 students in the control class, as shown by the two data points above. The following table presents the categories of N-Gain score acquisition. According to Ismono (2014), the N-Gain score categories are as follows:

**Table 11. *N-Gain Category***

| N-Gain Score | Category |
|---|---|
| $g > 0,7$ | High Effectivity |
| $0,3 \leq g \leq 0,7$ | Medium Effectivity |
| $G < 0,3$ | Low Effectivity |

The effectiveness of the enrichment module in this study was determined based on the N-Gain calculation derived from students' cognitive learning outcome data. The percentage of N-Gain obtained is presented as follows:

**Table 12.** ***Statistic Descriptive***

| Descriptive Statistic | | | | | |
|---|---|---|---|---|---|
| | N | Min | Max | Mean | Std. Deviation |
| Ngain score | 60 | 17 | 1,00 | 0,5772 | 19495 |
| N-gain percentage | 60 | 16,67 | 100,00 | 57,7220 | 19,49547 |
| Valid N | 60 | | | | |

From the table above, the N-Gain score shows a mean value of 0.5772, which falls into the moderate category. Meanwhile, the N-Gain percentage shows a mean of 57.7220, indicating that the treatment applied in this study was moderately effective.

Based on the results and discussion above, it was found that the posttest scores of the experimental class were higher than those of the control class. This means a significant difference exists between the class using the enrichment module and the class without the module. The difference in students' learning outcomes affects students' cognitive achievements in the biodiversity subject. This finding is consistent with the study conducted by (Mikuskova, 2023), which revealed that learning with enrichment modules improves academic performance and motivates students. Active, creative, and innovative learning can serve as a focal point for students to engage with the presented subject matter. (Dewi, 2022).

Furthermore, the analysis results indicate that students with a limited understanding of biodiversity significantly improved after using the enrichment module. This aligns with the study by Gladys and Fitri (2024), who stated that biodiversity materials require strong literacy skills so that students can easily grasp the concepts of identifying, classifying, and distinguishing levels and roles of biodiversity. This suggests that the module can assist students with varying levels of prior knowledge in achieving a higher level of understanding (Utami et al., 2015).

Descriptive analysis also showed that the experimental class achieved an average score of 81.67, which met the established Minimum Mastery Criteria (KKTP). This can be attributed to the experimental group's more structured and targeted learning process. Cognitive ability can be defined as an individual's capacity to apply acquired knowledge and insights optimally to problem-solving. (P. S. Wulandari et al., 2015). The use of enrichment modules also allows students to manage their learning process. (Handayani & Sulaiman, 2021). This self-directed learning significantly enhances students' independence, enabling them to study content at their own pace and according to their preferred learning styles.

Inferential analysis using a parametric test, specifically the Paired Sample T-Test, showed a significance value of 0.000. Since this value is less than 0.05 (0.000 < 0.05), it indicates that the enrichment module on the identification of *Rhodomyrtus tomentosa* (Karamunting) in biodiversity material is efficacious in improving students' cognitive abilities. According to Fauziah et al.,( 2023)A product's effectiveness can be assessed using four indicators: instructional quality, alignment, incentives, and time efficiency. This finding is also supported by Fatmi et al., (2021) Who demonstrated that practical learning modules can enhance cognitive outcomes and improve the overall efficiency and effectiveness of the teaching and learning process in schools, including in terms of time, cost, facilities, and teacher efforts in achieving learning objectives optimally.

Similarly, Mutmainnah et al., (2021) Their study titled "Effectiveness of E-Modules on Cognitive Learning Outcomes in Human Digestive System Material at Madrasah Tsanawiyah" found that using enrichment modules in biology learning significantly improved students' cognitive achievements. These enrichment modules allow students to broaden their horizons by providing additional material that is not only informative but also stimulates curiosity and enthusiasm for learning. This is further supported by Saparuddin et al., (2022), whose study showed that students using e-modules experienced improvement in their cognitive learning outcomes.

In addition, the effectiveness of the enrichment module was also tested by comparing the experimental group, which used the module, with the control group, which relied on conventional learning methods. Effectiveness was assessed using the N-Gain analysis, which yielded a mean percentage of 57.7220, indicating moderate effectiveness. A similar study (2014) showed that a biodiversity conservation module moderately improved students' learning outcomes. One of the key indicators of cognitive improvement through enrichment modules is analytical ability. Students actively involved in the enrichment module tended to demonstrate enhanced skills in breaking down complex information into simpler components. This is consistent with Mapilindo et al. (2021), who discussed enrichment modules designed to improve students' analytical abilities in problem-solving.

Moreover, enrichment materials can also stimulate students' critical and analytical thinking skills. According to Ennis, as cited in Prasetyo & Hakim, (2022)Critical thinking is a cognitive process focused on making decisions based on what is believed or practised. This finding is aligned with the research by Meganingrum, (2022), which stated that biodiversity enrichment e-modules are highly effective as instructional materials in teaching.

## CONCLUSION

The enrichment module on introducing *Rhodomyrtus tomentosa* (Karamunting) effectively improved students' cognitive learning outcomes on the biology topic of biodiversity, based on the data analysis and research findings. The hypothesis test results, showing mean pretest and posttest scores of 70.50 and 81.67, respectively, support this conclusion. These results indicate that in the class using the enrichment module, students' cognitive learning outcomes in biodiversity significantly improved. Furthermore, the mean N-Gain score of 0.5772 classifies the moderate increase in students' cognitive learning outcomes.

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