Journal of Mathematics Education and Application (JMEA)
Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

Development of a CLIL-Based Bilingual Calculus Module for Mathematical Problem-Solving and English Vocabulary for University Students

Noviyanti[1*], Fajrinur[2], Nelly Mursyidah[3]
[1,2,3]*Universitas Islam Kebangsaan Indonesia*
*Corresponding Author. E-mail: noviyanti.mizy@gmail.com

Article Info

Article History
Received 12-09-2026
Revision 12-09-2026
Accepted 29-10-2026

Keywords:

Bilingual;
Calculus Module;
CLIL;
English Vocabulary;
Mathematical Problem Solving.

ABSTRACT

This study aims to develop and evaluate a bilingual calculus module based on Content and Language Integrated Learning (CLIL) to support students' mathematical problem-solving ability and English vocabulary mastery. The study employed a Research and Development (R&D) approach using the ADDIE model. Module validity was evaluated by three experts specializing in content, language and CLIL integration, and instructional media. Practicality and learning outcomes were assessed using data from 35 Mathematics Education students in a one-group pretest-posttest design. Expert validation yielded an overall average score of 4.67 out of 5 (93.33%), categorized as highly valid. The student practicality questionnaire yielded a mean score of 2.73 out of 4 (68.21%), categorized as practical. Mathematical problem-solving mean scores increased from 51.60 to 74.54 (N-gain = 0.474), while English vocabulary scores increased from 55.23 to 75.97 (N-gain = 0.463), with both gains categorized as moderate. Paired-samples t-tests indicated statistically significant pretest-posttest differences ($p < .001$), with paired-samples effect sizes (d_z) of 3.905 and 2.420, respectively. These findings suggest that the CLIL-based bilingual calculus module is a potentially useful instructional resource, although the absence of a control group limits causal conclusions.

To cite this article:

INTRODUCTION

English language proficiency is a critical competency for mathematics education students because most of the literature, scientific journals, and advanced mathematics learning resources are presented in English. Large-scale research based on PISA data shows that the amount of time spent learning a foreign language in school is positively and significantly associated with students' mathematics achievement across countries, even after controlling for socioeconomic status and school factors (Nucette et al., 2026). Similar findings also report that language proficiency is one of the predictors of secondary students' mathematics achievement (Ortega-Rodríguez, 2025).

Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

Content and Language Integrated Learning (CLIL) is an approach that simultaneously integrates content mastery and foreign language development through four components: Content, Communication, Cognition, and Culture. A recent meta-analysis of CLIL-based learning at the secondary level reported a positive effect on students' content mastery compared to single-language instruction (Kaiypova et al., 2025). However, a systematic review of the CLIL literature over the past decade found that research remains dominated by linguistic benefits, while studies focusing on content mastery in subjects such as mathematics remain very limited and have not yielded consistent conclusions (Hidalgo & Ortega-Sánchez, 2023).

A systematic literature review specifically examining mathematics instruction through CLIL, Content-Based Instruction (CBI), and English Medium Instruction (EMI) further confirms that the number of studies focusing on mathematics remains very small compared to other subjects (Ruiz-Cecilia et al., 2023). In fact, mathematics and language are closely intertwined: mastery of vocabulary and language structures helps determine how students understand and represent mathematical problems in a bilingual environment (Ester et al., 2024). The pedagogical principle of translanguaging (the flexible use of students' entire linguistic repertoire) has also been shown to help students from diverse linguistic backgrounds understand science and mathematics content in English (Tai, 2021) and to support teachers in managing content-language integration reflectively (Nguyen et al., 2025).

Nevertheless, the positive effects of bilingual learning on mathematics are not always consistent. Studies on the role of the first language (L1) in bilingual mathematics learning indicate that learning opportunities are significantly influenced by the extent to which the medium of instruction is facilitated as a resource, rather than merely a barrier (Malaki et al., 2022), while a study of early bilingual immersion among French-speaking children found that the cognitive benefits of CLIL on arithmetic skills depend on the duration of exposure and the target language being learned (Gillet et al., 2021). These findings highlight the importance of a well-designed bilingual learning program, rather than simply delivering content in a foreign language.

These findings are further supported by a longitudinal study of bilingual children showing that the language of instruction influences the development of mathematical thinking in the early years of formal education (Bermejo et al., 2021), as well as a recent systematic review of 71 experimental studies concluding that bilingualism does not necessarily reduce mathematical performance, but its impact depends on students' level of language proficiency (González-Martín et al., 2024).

In the context of higher education in Indonesia, the implementation of English Medium Instruction still faces challenges related to the language readiness of both students and faculty (Bolton et al., 2023). On the other hand, calculus courses are known to require a high level of mathematical problem-solving ability, including the ability to connect mathematical concepts to one another (Pambudi et al., 2020) and to integrate conceptual and procedural knowledge in solving derivative and integral problems (Hechter et al., 2022). Presenting calculus material in two languages simultaneously has the potential to increase cognitive load if not designed with the appropriate learning approach.

Recent studies published in the Journal of Mathematics Education and Application have highlighted the importance of developing instructional materials and integrating innovative learning approaches into mathematics education. Salsabila and Maryanti (2026) developed electronic student worksheets (E-LKPD) integrated with Realistic Mathematics Education (RME) to support students' critical thinking skills in mathematics learning. Similarly, Husna et al. (2026) investigated Quizizz-based interactive digital media in mathematics learning, demonstrating the relevance of technology-supported instructional approaches. These studies provide useful perspectives on instructional innovation in mathematics education. However, they do not specifically address the integration of calculus content and English mathematical vocabulary within a CLIL-based bilingual module. Therefore, the present study focuses on developing instructional materials that systematically integrate mathematical problem-solving activities and English vocabulary support in university-level calculus learning.

Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

Although previous studies have examined the role of language in mathematics learning and the implementation of Content and Language Integrated Learning in bilingual education, limited attention has been given to the development of bilingual instructional modules that explicitly integrate university-level calculus problem solving with mathematical English vocabulary development. Existing research has also highlighted variations in the effectiveness of bilingual instruction across educational contexts. These findings indicate the need for instructional materials that systematically connect mathematical concepts, problem-solving activities, and language support. Accordingly, the present study addresses this need through the development and evaluation of a CLIL-based bilingual calculus module using the ADDIE model.

Based on the identified research gaps, this study aims to (1) develop a CLIL-based bilingual calculus module using the ADDIE model, (2) evaluate the validity and practicality of the developed module, and (3) examine changes in students' mathematical problem-solving ability and English vocabulary mastery following its implementation. The novelty of this study lies in the systematic integration of university-level calculus content, mathematical problem-solving activities, and English vocabulary development within a single instructional module grounded in the four principles of CLIL: Content, Communication, Cognition, and Culture.

RESEARCH METHOD

This study is a research and development (R&D) project that employs the ADDIE model, comprising the stages of Analysis, Design, Development, Implementation, and Evaluation, as is commonly used in the development of mathematics modules based on specific learning approaches (Islahiyah et al., 2021; Sidik & Rumbia, 2021). This model was chosen because it is systematic and oriented toward gradual (formative) improvement at each stage. Three types of research instruments were employed to evaluate the validity, practicality, and effectiveness of the CLIL-based bilingual calculus module: expert validation sheets, a student practicality questionnaire, and learning outcome tests.

Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

The expert validation sheets were used to evaluate three aspects of the developed module: calculus content, language and CLIL integration, and instructional media. Three experts participated in the validation process, consisting of one calculus content expert, one language and CLIL expert, and one instructional media expert. Each expert evaluated six indicators within their respective areas using a five-point rating scale. The evaluation focused on the appropriateness of the module in supporting mathematical content learning, bilingual language integration, and instructional presentation.

The student practicality questionnaire consisted of eight statements rated on a four-point scale. The questionnaire was designed to assess students' perceptions of the module's usability and suitability for learning. The evaluation included students' responses regarding the clarity of the instructional materials, ease of understanding, attractiveness of the learning presentation, and relevance of the module to their learning needs.

The learning outcome instruments consisted of two tests: a mathematical problem-solving test and an English mathematical vocabulary test. Both tests were administered before and after the implementation of the developed module to 35 Mathematics Education students. The mathematical problem-solving test was used to assess students' performance in solving calculus problems, while the English mathematical vocabulary test measured their mastery of mathematical terminology presented in English. Scores from both tests were reported on a scale ranging from 0 to 100.

The expert validation sheets, practicality questionnaire, and learning outcome tests served different evaluation purposes. Expert validation was used to assess the quality of the developed module, the practicality questionnaire measured students' perceptions of its use, and the pretest-posttest instruments provided information about changes in students' mathematical problem-solving performance and English vocabulary mastery following module implementation.

Journal of Mathematics Education and Application (JMEA)
Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

Instrument Validity and Reliability

The evaluation of the developed module was distinguished from the psychometric assessment of the research instruments. The module was evaluated in terms of calculus content, language and CLIL integration, and instructional media using assessment sheets comprising six indicators for each aspect on a five-point scale.

Internal consistency was assessed using item-level records from 35 participants in the main study. No separate pilot testing was conducted. Cronbach's alpha was used for the eight-item student practicality questionnaire and the five-item mathematical problem-solving test, whereas the Kuder–Richardson Formula 20 (KR-20) was applied to the 20-item English vocabulary test with dichotomous scoring. The reliability estimates are presented in the Results section. Separate item-level validity analyses and documented expert-based content validation of the learning outcome tests were not available. Therefore, internal consistency was interpreted as reliability evidence rather than proof of comprehensive instrument validity.

Development Procedure (ADDIE)
All stages of the ADDIE model are presented in Figure 1 below.

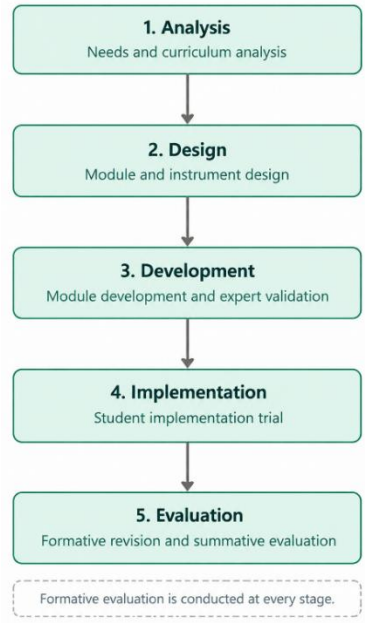


Figure 1. Development Procedure

Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

The Analysis phase involves analyzing student needs, the Calculus course curriculum, and students' prior mathematical and English language proficiency. The Design phase involves creating concept maps of the material (limits, derivatives, and integrals), determining the module structure, and designing content-language integration in accordance with the 4C principles of CLIL. The Development stage involves the creation of the module and its validation by subject matter, language, and media experts, followed by revisions based on the validators' suggestions. The Implementation stage involves testing the module with students using a one-group pretest-posttest design. The Evaluation stage is conducted formatively at each stage and summatively through an analysis of validity, practicality, and effectiveness based on data from the implementation results. These stages provide a systematic framework for developing, validating, implementing, and evaluating the instructional module through an iterative process of formative improvement (Asma & Sylvia, 2024).

Data Analysis Techniques

The data were analyzed to evaluate three aspects of the developed CLIL-based bilingual calculus module: validity, practicality, and effectiveness. Module validity was assessed through expert evaluation of content, language and CLIL integration, and instructional media. Each expert evaluated six indicators using a five-point rating scale. The average validation scores were converted into percentages by dividing the obtained scores by the maximum possible scores and multiplying by 100. Module practicality was evaluated using student responses to an eight-item questionnaire rated on a four-point scale. Practicality percentages were calculated using the same proportional scoring procedure.

The validity and practicality percentages were interpreted using five assessment categories adapted from Riduwan (2015). These criteria were applied to classify the expert validation and student practicality assessment scores. The interpretation criteria are presented in Table 1.

Table 1. Criteria for Validity and Practicality Assessment

Percentage Range	Validity Category	Practicality Category
80% < P ≤ 100%	Highly Valid	Highly Practical
60% < P ≤ 80%	Valid	Practical
40% < P ≤ 60%	Moderately Valid	Moderately Practical
20% < P ≤ 40%	Less Valid	Less Practical
0% ≤ P ≤ 20%	Invalid	Impractical

Note. P represents the percentage obtained from the assessment score.

The effectiveness evaluation employed a one-group pretest-posttest design involving 35 Mathematics Education students. Descriptive statistics were used to summarize mathematical problem-solving and English vocabulary scores before and after implementation. Normalized gain was calculated from the group mean pretest and posttest scores, using 100 as the maximum possible score. N-gain values were classified as high ($g \geq 0.70$), moderate ($0.30 \leq g < 0.70$), or low ($g < 0.30$). Paired-samples t-tests were used to assess mean differences at a significance level of $\alpha = .05$. The standardized mean differences were calculated as Cohen's d_z by dividing the mean paired difference by its standard deviation.

$$d_z = \frac{\overline{D}}{SD_D}$$

where d_z represents the standardized mean difference for paired samples, $\overline{D}$ denotes the mean difference between posttest and pretest scores, and SD_D represents the standard deviation of the paired differences.

The statistical results were interpreted by considering the significance level, normalized gain scores, and standardized effect sizes. Given the absence of a control group, the findings were used to describe changes in student performance rather than establish a causal relationship between module implementation and learning outcomes.

Journal of Mathematics Education and Application (JMEA)
Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

RESULTS AND DISCUSSION

Results

The results of the expert validation of the Content and Language Integrated Learning (CLIL) based bilingual calculus module are presented in Table 2.

Table 2. Results of the expert validation of the module

Assessment Criteria	Average Score	Percentage	Category
Content	4.50	90.00%	Highly Valid
CLIL	4.67	93.33%	Highly Valid
Media/Design	4.83	96.67%	Highly Valid
Overall Average	4.67	93.33%	Highly Valid

The expert validation scores indicated that all three assessment aspects met the highly valid category. The content assessment obtained 90.00%, language and CLIL integration obtained 93.33%, and media and design obtained 96.67%. The overall average was 4.67 out of 5, equivalent to 93.33%. These results suggest that the developed module satisfied the adopted feasibility criteria across the assessed aspects.

The student practicality questionnaire administered to 35 Mathematics Education students yielded a mean score of approximately 2.73 out of 4, corresponding to 68.21% of the maximum possible score. Based on the adopted interpretation criteria, the developed module was categorized as practical. These results indicate a satisfactory overall level of perceived practicality among the participating students. However, further item-level interpretation is required to determine which aspects of the module received the strongest and weakest student evaluations (Maskur et al., 2020; Sari & Hapizah, 2020).

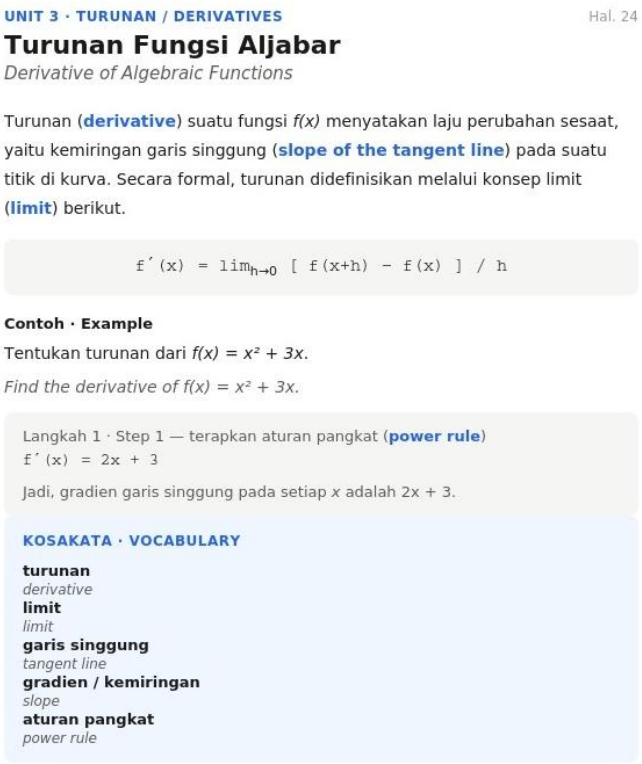
The internal consistency analysis yielded a Cronbach's alpha coefficient of 0.870 for the eight-item student practicality questionnaire and 0.902 for the five-item mathematical problem-solving test. The 20-item English vocabulary test obtained a KR-20 coefficient of

0.769. These results indicate satisfactory internal consistency for the three research instruments within the recorded sample. However, the reliability coefficients do not independently establish content validity or other forms of instrument validity.

The results of the module's effectiveness test on mathematical problem-solving skills and English vocabulary mastery among 35 students are presented in Table 3.

Table 3. Results of the module's effectiveness test

Variable	Pretest	Posttest	N-Gain	Category	Sig. (p)	Cohen's d_z
Mathematical Problem Solving	51.60	74.54	0.474	Moderate	< 0.001	3.905
English Vocabulary	55.23	75.97	0.463	Moderate	< 0.001	2.420


UNIT 3 · TURUNAN / DERIVATIVES Hal. 24

Turunan Fungsi Aljabar

Derivative of Algebraic Functions

Turunan (**derivative**) suatu fungsi *f(x)* menyatakan laju perubahan sesaat, yaitu kemiringan garis singgung (**slope of the tangent line**) pada suatu titik di kurva. Secara formal, turunan didefinisikan melalui konsep limit (**limit**) berikut.

$$f'(x) = \lim_{h \to 0} [\, f(x+h) - f(x) \,] / h$$

Contoh · Example

Tentukan turunan dari $f(x) = x^2 + 3x$.

Find the derivative of $f(x) = x^2 + 3x$.

Langkah 1 · Step 1 — terapkan aturan pangkat (**power rule**)

$f'(x) = 2x + 3$

Jadi, gradien garis singgung pada setiap *x* adalah 2x + 3.

KOSAKATA · VOCABULARY

turunan *derivative*
limit *limit*
garis singgung *tangent line*
gradien / kemiringan *slope*
aturan pangkat *power rule*

Figure 2. Sample Page of the Developed CLIL-Based Bilingual Calculus Module

The results showed improvements in both mathematical problem-solving ability and English vocabulary mastery following implementation of the developed module. The mean mathematical problem-solving score increased from 51.60 to 74.54, with an N-gain of 0.474. The mean English vocabulary score increased from 55.23 to 75.97, with an N-gain of 0.463. Both normalized gain values were categorized as moderate. Paired-samples t-tests indicated statistically significant differences for mathematical problem-solving ability, $t(34) = 23.100$, $p < .001$, and English vocabulary mastery, $t(34) = 14.315$, $p < .001$. The corresponding paired-samples standardized mean differences were 3.905 and 2.420, respectively. These results indicate improvements within the participating group but do not establish that the module alone caused the observed changes.

Discussion

The findings indicated moderate normalized gains in mathematical problem-solving ability and English vocabulary mastery following implementation of the CLIL-based bilingual calculus module. This pattern is consistent with previous research suggesting that Content and Language Integrated Learning can support content learning (Kaiypova et al., 2025). Integrating mathematical explanations with English vocabulary may create opportunities for students to connect conceptual understanding and disciplinary language. Mathematical vocabulary can support the interpretation of mathematical problems, while contextualized problem-solving activities may reinforce students' familiarity with mathematical terminology (Ester et al., 2024). Nevertheless, the improvements observed in the present study should be interpreted cautiously because no comparison group was included.

This mechanism of improvement can be explained through the principle of translanguaging implicitly applied in the module, namely that students are given the opportunity to connect English terms with the conceptual understanding they already possess in Indonesian, as has been found to support the understanding of science and mathematics content among multilingual learners (Tai, 2021) and to support instructors'

pedagogical reflection in managing content-language integration (Nguyen et al., 2025). In terms of problem-solving, this significant improvement is also consistent with the importance of the ability to connect mathematical concepts as a prerequisite for solving calculus problems (Pambudi et al., 2020), and is relevant to findings that strengthening conceptual knowledge supports the solution of procedural calculus problems, such as derivative and integral problems (Hechter et al., 2022).

More specifically, experimental studies show that language-based instruction can have a causal effect on the development of mathematical ability, rather than merely being correlated with it (Espinas & Fuchs, 2022). These findings suggest that mathematical vocabulary development may play a supportive role in students' problem-solving processes, although the present study did not directly test this mechanism.

The observed improvements are consistent with previous research indicating an association between foreign language learning and mathematics achievement (Nucette et al., 2026). Language proficiency has also been identified as a predictor of mathematics achievement (Ortega-Rodríguez, 2025). However, these studies differ from the present research in their designs, participants, and outcome measures. Therefore, their findings should be interpreted as contextual support rather than direct evidence of the effectiveness of the developed module. The present study contributes additional evidence concerning the integration of calculus learning and mathematical English vocabulary in Indonesian higher education, although further controlled investigations are required.

It should be noted that the benefits of bilingual learning for mathematics are not always consistent across different contexts. Studies on the role of the first language indicate that opportunities for bilingual mathematics learning depend heavily on the extent to which the mother tongue is facilitated as a learning resource, rather than ignored (Malaki et al., 2022), while studies on early bilingual immersion report that the cognitive benefits of CLIL on arithmetic skills vary depending on the duration of exposure and the language being learned (Gillet et al., 2021). The modules in this study were designed to address this by

continuing to include conceptual explanations in Indonesian as a support, so that English serves to reinforce conceptual understanding rather than replace it.

In terms of validity and practicality, the findings are consistent with previous studies reporting favorable evaluations of ADDIE-based mathematics instructional modules (Asmar et al., 2024; Mahendra et al., 2025; Syahril et al., 2023). These findings suggest that systematic development procedures, expert validation, and formative revision can contribute to the production of feasible instructional materials.

The findings regarding effectiveness in this study are also consistent with a pilot study of CLIL students at the secondary level, which found that the use of a second language in mathematics tests influences the process of solving word problems; therefore, the reinforcement of language comprehension needs to be explicitly designed rather than assumed to occur naturally (Cabezuelo & Pavón, 2019).

Several limitations should be acknowledged. First, the one-group pretest-posttest design lacked a comparison group, restricting causal interpretation of the observed improvements. Second, the effectiveness evaluation involved 35 participants from a single study program, limiting the generalizability of the findings. Third, although internal consistency reliability was examined, separate item-level validity analyses and documented content validation of the learning outcome tests were unavailable. The assessment records and scoring procedures should also be sufficiently documented to support independent verification of the reported findings. Future studies should employ controlled research designs, include more diverse participants, and strengthen the documentation and validation of the research instruments.

CONCLUSION

This study developed a CLIL-based bilingual calculus module using the ADDIE model to integrate mathematical content learning and English vocabulary development. Expert validation yielded an overall score of 93.33%, categorized as highly valid. The student practicality assessment yielded 68.21%, categorized as practical. Mathematical problem-solving scores increased from 51.60 to 74.54, with an N-gain of 0.474, while English vocabulary scores increased from 55.23 to 75.97, with an N-gain of 0.463. Both normalized gains were categorized as moderate and paired-samples t-tests indicated statistically significant within-group improvements. These findings suggest that the module has potential as an instructional resource for integrating calculus content and English vocabulary in higher education. However, the absence of a comparison group and the limited evidence of instrument validity restrict the conclusions. Future studies should employ controlled designs and strengthen instrument validation procedures.

REFERENCES

Asma, N., & Sylvia, R. (2024). Developing Proteus video tutorials as interactive mathematics learning media based on a realistic approach. *AXIOM: Jurnal Pendidikan Dan Matematika*, *13*(2), 127–138.

Asmar, S. E., Armiati, Arnawa, I. M., & Yarman. (2024). Pengembangan modul ajar matematika berbasis problem based learning untuk meningkatkan kemampuan pemecahan masalah matematis siswa kelas VII SMP. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *13*(1), 304–314. https://doi.org/10.24127/ajpm.v13i1.8368

Bermejo, V., Ester, P., & Morales, I. (2021). How the language of instruction influences mathematical thinking development in the first years of bilingual schoolers. *Frontiers in Psychology*, *12*, 533141. https://doi.org/10.3389/fpsyg.2021.533141

Bolton, K., Hill, C., Bacon-Shone, J., & Peyronnin, K. (2023). EMI (English-medium instruction) in Indonesian higher education. *World Englishes*, *42*(3), 424–446.

Cabezuelo, R., & Pavón, V. (2019). Analysing mathematical word problem solving with secondary education CLIL students: A pilot study. *Latin American Journal of Content and Language Integrated Learning*, *12*(1). https://doi.org/10.5294/laclil.2019.12.1.2

Espinas, D. R., & Fuchs, L. S. (2022). The effects of language instruction on math development. *Child Development Perspectives*, *16*(2), 69–75. https://doi.org/10.1111/cdep.12444

Ester, P., Moraleda, Á., & Morales, I. (2024). Mathematics and language: A one-to-one correspondence in bilingual environments. *Education Sciences*, *14*(3), 328. https://doi.org/10.3390/educsci14030328

Gillet, S., Barbu, C., Poncelet, M., & Filippi, R. (2021). Early bilingual immersion school program and cognitive development in French-speaking children: Effect of the second language learned (English vs. Dutch) and exposition duration (2 vs. 5 years). *PLOS ONE*, *16*(10), e0258458. https://doi.org/10.1371/journal.pone.0258458

González-Martín, A. M., Berd-Gómez, R., Saura-Montesinos, V., Biel-Maeso, M., & Abrahamse, E. (2024). On the relationship between bilingualism and mathematical performance: A systematic review. *Education Sciences*, *14*(11), 1172. https://doi.org/10.3390/educsci14111172

Hechter, J., Stols, G., & Combrinck, C. (2022). The reciprocal relationship between conceptual and procedural knowledge—A case study of two calculus problems. *African Journal of Research in Mathematics, Science and Technology Education*, *26*(2), 111–124. https://doi.org/10.1080/18117295.2022.2101271

Hidalgo, D. R., & Ortega-Sánchez, D. (2023). CLIL (Content and Language Integrated Learning) methodological approach in the bilingual classroom: A systematic review. *International Journal of Instruction*, *16*(3), 915–934. https://doi.org/10.29333/iji.2023.16349a

Husna, Z., Azis, Z., & Harahap, T. H. (2026). The effect of quizizz-based digital interactive media on students' learning outcomes and engagement in learning linear equations.

Journal of Mathematics Education and Application, *5*(2), 54–62. https://doi.org/10.30596/jmea.v5i2.31553

Islahiyah, I., Pujiastuti, H., & Mutaqin, A. (2021). Pengembangan e-modul dengan model pembelajaran berbasis masalah untuk meningkatkan kemampuan pemecahan masalah matematis siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4), 2107–2118. https://doi.org/10.24127/ajpm.v10i4.3908

Kaiypova, F., Lee, H., Lo, Y. Y., & Lee, J. H. (2025). Effects of Content and Language Integrated Learning on secondary-level students' content learning: A meta-analysis. *System*, *129*, 103580. https://doi.org/10.1016/j.system.2024.103580

Mahendra, A., Armiati, Musdi, E., & Suherman. (2025). Pengembangan modul ajar berbantuan E-LKPD berbasis creative problem solving untuk meningkatkan kemampuan pemecahan masalah matematis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *14*(4).

Malaki, M., Aminifar, E., Mesgarani, H., & Alipour, M. (2022). Learning opportunities in mathematics: The role of first language in bilingual settings. *SN Social Sciences*, *2*, 8. https://doi.org/10.1007/s43545-021-00304-5

Maskur, R., Permatasari, D., & Rakhmawati, R. M. (2020). Pengembangan bahan ajar matematika berbasis Rhythm Reading Vocal pada materi konsep pecahan kelas VII SMP. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *11*(1), 78–87. https://doi.org/10.15294/kreano.v11i1.23562

Nguyen, H. T. M., Nguyen, H. T. T., Gilanyi, L., Hoang, T. H., & Gao, X. (2025). Content Language Integrated Learning (CLIL): Teachers' metacognitive understanding of pedagogical translanguaging. *Learning and Instruction*, *97*, 102085. https://doi.org/10.1016/j.learninstruc.2025.102085

Nucette, A., Biedermann, B., Leitão, S., & Hamamura, T. (2026). Unlocking mathematical potential through school-based language learning: Insights from PISA 2018. *Bilingualism: Language and Cognition*. https://doi.org/10.1017/S1366728926101138

Ortega-Rodríguez, P. J. (2025). PISA 2022. Predictors of the mathematics achievement of Spanish students in Secondary Education. *Revista de Psicodidáctica (English Edition)*, *30*(1).

Pambudi, D. S., Budayasa, I. K., & Lukito, A. (2020). The role of mathematical connections in mathematical problem solving. *Jurnal Pendidikan Matematika*, *14*(2), 129–144. https://doi.org/10.22342/jpm.14.2.10985.129-144

Riduwan. (2015). *Skala pengukuran variabel-variabel penelitian*. Alfabeta.

Ruiz-Cecilia, R., Medina-Sánchez, L., & Rodríguez-García, A.-M. (2023). Teaching and learning of mathematics through CLIL, CBI, or EMI—A systematic literature review. *Mathematics*, *11*(6), 1347. https://doi.org/10.3390/math11061347

Salsabila, S., & Maryanti, I. (2026). Development of mathematics E-LKPD integrated with Realistic Mathematics Education (RME) to improve students' critical thinking skills. *Journal of Mathematics Education and Application*, *5*(2), 75–84. https://doi.org/10.30596/jmea.v5i2.31574

Sari, R. M., & Hapizah. (2020). Pengembangan bahan ajar program linear berbasis android untuk pembelajaran berbasis masalah. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *11*(2), 161–172. https://doi.org/10.15294/kreano.v11i2.25278

Sidik, M. K., & Rumbia, L. (2021). Pengembangan modul matematika dengan pendekatan saintifik untuk meningkatkan kemampuan pemecahan masalah matematika. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4), 2826–2834. https://doi.org/10.24127/ajpm.v10i4.4250

Syahril, R. F., Saragih, S., & Suanto, E. (2023). Pengembangan modul ajar berbasis problem based learning untuk memfasilitasi kecakapan pemecahan masalah matematis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(2), 1987–1997. https://doi.org/10.24127/ajpm.v12i2.6923

Tai, K. W. (2021). Translanguaging as inclusive pedagogical practices in English-medium instruction science and mathematics classrooms for linguistically and culturally

Vol. 05, No 3, October 2026 , pp. 166-183 DOI: https://doi.org/10.30596/jmea.v5i1.32190

diverse students. *Research in Science Education*, 1–38.