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Development of Differentiated Teaching Modules Based on Learning Styles in Project IPAS to Improve Students' Collaboration Skills

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Abstract: This study aims to develop a differentiated teaching module based on students' learning styles in the Project-Based Learning of Natural and Social Sciences (IPAS) to improve collaboration skills. The research employed a Research and Development (R&D) approach using the ADDIE model, which includes five phases: analysis, design, development, implementation, and evaluation. The subjects of the study were Grade X students at SMK Negeri 1 Parigi, with 19 students from the *Akuntansi dan Keuangan Lembaga* (AKL) program as the experimental class and 19 students from the *Desain Pemodelan dan Informasi Bangunan* (DPIB) program as the control class. Research instruments included expert validation sheets, practicality questionnaires, cognitive assessment tests (pretest and posttest), and observation sheets for collaboration skills. Validation results showed that the module achieved a validity level of 83%, categorized as valid. The module's practicality was rated at 92% by teachers and 95% by students, both classified as highly practical. Regarding effectiveness, a comparison of posttest scores between the experimental and control groups yielded a Cohen's d of 0.93, indicating a large effect on students' cognitive outcomes. Additionally, within the experimental group, a comparison of pretest and posttest collaboration scores resulted in a Cohen's d of 0.89, also classified as a large effect. These findings demonstrate that the differentiated teaching module effectively enhances students' 21st-century skills, particularly collaboration.

Keywords: Collaboration; Differentiated learning; Learning styles; Project IPAS

Introduction

The 21st century requires the world of education to make fundamental transformations in responding to dynamic changes in the times. Learners are required not only to master cognitive aspects, but also to develop 21st century skills known as 6C: collaboration, critical thinking, creativity, communication, citizenship, and character (Putri et al., 2024). To answer these challenges, the Indonesian government implemented the Merdeka Curriculum which emphasizes flexibility, strengthening character, and developing learner competencies according to individual needs and potential (Suryani et al., 2023).

One of the main approaches in the Merdeka Curriculum is differentiated learning, which is a learning strategy tailored to students' learning readiness, interests, and learning styles. This approach is very relevant in the context of a heterogeneous classroom, because it recognizes that each learner is a unique individual (Sarnoto, 2024). This learning becomes important to accommodate the diverse

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characteristics of learners in the classroom (Mahfudz-MZ, 2023). However, its implementation in the field shows that most teachers are still confused in integrating learners' learning readiness and learning styles appropriately (Jatmiko et al., 2022), and often feel less confident due to limited knowledge and continuous training (Elviya et al., 2023). As a result, the potential of differentiated learning has not been optimally utilized to create meaningful learning experiences and motivate learners (Gymnastiar, 2024). This is due to the old paradigm that considers learners as homogeneous entities, limitations in knowledge about learning styles, and lack of in-depth training (Setiawan et al., 2023; Herwina, 2021; Fitriah & Widiyono, 2023).

One of the main challenges in implementing differentiated learning is the limited number of teaching modules specifically designed to support this approach (D. Kuntuamas et al., 2025). Differentiated teaching modules have a central role in supporting teachers to be able to design learning experiences that suit learner profiles, including visual, auditory, and kinesthetic learning styles (Aprima & Sari, 2022; Puspita et al., 2023; Hayati et al., 2024). However, the availability of teaching modules that are relevant and adaptive to this diversity is still minimal, causing less optimal learning and not fully meeting the individual needs of students (Derici & Susanti, 2023; Herlina et al., 2023).

Collaboration skills are one of the skill competencies of the 21st century that are very important for students. Collaboration refers to the ability to work together in groups, share ideas, listen to others' opinions, and solve problems collectively. In the context of 21st-century learning, students are required not only to master cognitive knowledge but also to have social skills such as the ability to work together (Hidayati, 2019).

Unfortunately, many teachers have yet to explicitly integrate collaborative skills into their lesson plans or teaching modules. Existing research also tends to focus more on individual aspects such as independent learning and critical thinking (Azka et al., 2024; Hidayat et al., 2023). However, collaborative skills are essential for students' success in the workplace and social life. Observations at SMK Negeri 1 Parigi shows that students still have difficulty working in groups, sharing tasks, and listening to the opinions of their peers. This situation is exacerbated by a teacher-centered approach to learning, which does not provide sufficient space for participation.

Through the application of differentiated learning strategies based on learning styles and interests, teachers can design group activities that strengthen social interaction. For example, in collaborative projects in the Project IPAS subject, students can be grouped based on visual, auditory, or kinesthetic preferences, and given tasks that require each member to contribute according to their strengths.

The development of structured and systematic teaching modules can support teachers in implementing these strategies. These modules should be designed to encourage teamwork, joint decision-making, and group evaluation, so that students not only understand the material but also hone their collaborative skills (Maulida, 2022).

However, existing studies rarely combine differentiated learning based on learning styles with collaborative learning in the context of vocational education, especially in the IPAS subject. This creates a gap that this study intends to address. Therefore, this study specifically aims to develop a differentiated teaching module based on students' learning styles in the IPAS project to improve students' collaboration and creativity skills. The novelty of this study lies in the integration of differentiated instruction with project-based learning tailored to vocational high school students' learning profiles.

This research is important because it offers a practical solution to the scarcity of contextual, adaptive teaching modules, and provides empirical evidence of their impact on improving 21st-century skills.

Method

The type of research conducted is research and development. The purpose of choosing development research is to develop a product in the form of a differentiated teaching module. The model used is the ADDIE development model which systematically includes the analysis stage which the researchers conducted interviews with Project IPAS teachers to identify learning needs and conduct non-cognitive diagnostic assessments to map students' learning styles into visual, auditory, and kinesthetic categories, and analyze learning outcomes as a basis for determining learning objectives. In the design stage, the initial design of the differentiated teaching module was prepared, which includes the module structure (objectives, materials, assessments, learning activities, LKPD), as well as the preparation of research instruments such as validation sheets, practicality questionnaires, skill observation sheets, and pretest- posttest questions. The development stage involved by compiling the initial product of the module (product 1) which is then validated by two experts in terms of content, language, appearance, and usability; the validation results are used as the basis for revision to produce the final product (product 2) which is ready to be implemented. In the implementation stage, the differentiated teaching module was implemented only in the experimental

class, which consisted of Grade X students in the Accounting and Institutional Finance Program (AKL). Meanwhile, students in the Building Information Modeling Design Program (DPIB) served as the control class and were taught using conventional methods without the differentiated module and data collection is carried out through observation, questionnaires, and tests to determine the effectiveness and response to the use of the module. The evaluation phase involved analyzing the validation and practicality data of the module, as well as measuring its effectiveness. Effectiveness was assessed by comparing posttest results of the experimental (AKL) and control (DPIB) classes to calculate Cohen's d effect size for cognitive outcomes, and by comparing pretest and posttest scores in the experimental class only to measure gains in collaboration skills.

The stages of the development type research can be seen more clearly in flow chart on Figure 1.

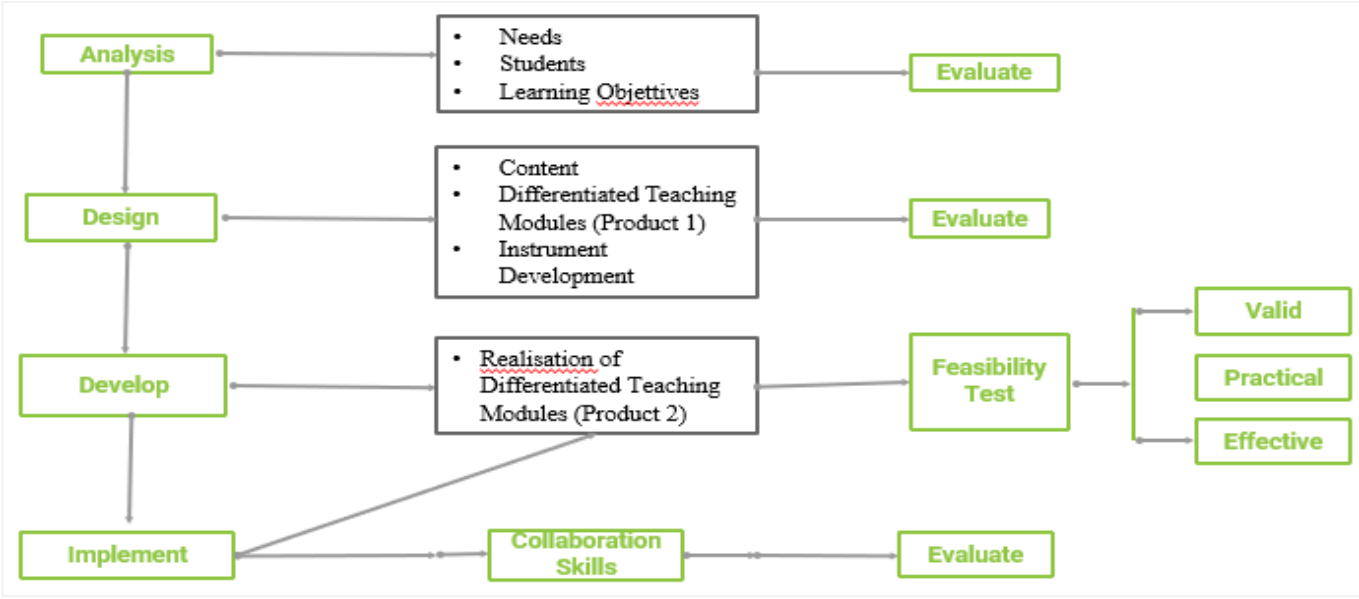

Figure 1. ADDIE development flow

The research was conducted in March-May 2025 at SMK Negeri 1 Parigi, Sulawesi Tengah, with the research subjects being grade X students majoring in *Akuntansi dan Keuangan Lembaga* (AKL) as the experimental class and *Desain Pemodelan dan Informasi Bangunan* (DPIB) as the control class. Data collection techniques included questionnaires, observations, tests, and documentation, while the research instruments consisted of expert validation sheets, practicality questionnaires, observation sheets for collaboration skills, as well as pretest and posttest questions. Data analysis was carried out by calculating the percentage of validity (view Table 1) and practicality (view Table 2), as well as the effectiveness of the module using the Cohen's d formula (view Table 3), then to see the improvement of collaboration skills of students with interpretation categories to determine the level of influence of the use of modules on 21st century skills developed.

Validation data of differentiated teaching modules are obtained from the results of validation by experts with validation sheet instruments which can be analyzed based on validity criteria (Jannah et al., 2022).

Table 1. Validity Critera

Criteria	Validity Level	Description
85.01% -100%	Very valid	Can be used, without revision
70.01% - 85.00%	Valid	Can be used, after minor revision
50.01% -70.00%	Not valid	Recommended not to be used because it needs major revision
0% - 50.00%	Not valid	Should not be used, major revision

The analysis of the practicality of using differentiated teaching module products is seen from the results of the student response questionnaire and also the teacher response questionnaire. Data on the results of learning implementation were analyzed for practicality using the practicality criteria in Table 2.

Test the effectiveness of the teaching module using Cohen's effect size formula, which is the difference in the incidence of the effect size of the strength of an

independent variable affecting the dependent variable, which in this case is the application of differentiated teaching modules to measure collaboration of students.

Table 2. Practicality Criteria (Sarip et al., 2022)

Percentage	Practicality Criteria
80% - 100%	Very practical
60% - 79%	Practical
40% - 59%	Less practical
20% - 35%	Not practical
0% - 19%	Very not practical

Table 3. Effectiveness Criteria (Yelpaze et al., 2020)

Effect Size Value	Interpretation
0.00 – 0.20	Negligible effect
0.21 – 0.50	Minor effect
0.51 – 0.80	Medium effect
0.81 – 1.30	Large effect
> 1.30	Very large effect

Furthermore, after assessing effectiveness, then also analyzing the improvement of collaboration skills with indicators on collaboration skills are: responsibility, respect others, contribute, organize work, and work as a whole team (Hidayati, 2019), then analyze using the effectiveness criteria in Table 3 and see the learner skill categories in Table 4.

Table 4. Skill Criteria (Hamidah et al., 2023)

Percentage interval	Category
81-100 %	Highly Skilled
61-80%	Skilled
41-60%	Moderately Skilled
21-40%	Less Skilled
0-20%	Very less

Result and Discussion

Analysis

The research results are presented based on the five stages of the ADDIE development model, namely analysis, design, development, implementation, and evaluation. At the analysis stage, needs identification was carried out by interviewing three IPAS Project teachers at SMK Negeri 1 Parigi. The results of the interviews showed that teachers had never developed differentiated teaching modules based on learning styles, and had not explicitly integrated collaboration skills and creativity in learning. In addition, a non-cognitive diagnostic assessment was conducted to map students' learning styles into visual, auditory and kinesthetic categories (see Figure 2). The mapping results show the variety of learning styles that need to be accommodated in the learning process. Furthermore, the learning objectives were analyzed based on the IPAS learning outcomes to develop learning objectives that are relevant and contextual to the selected material, namely the bioplastic making project.

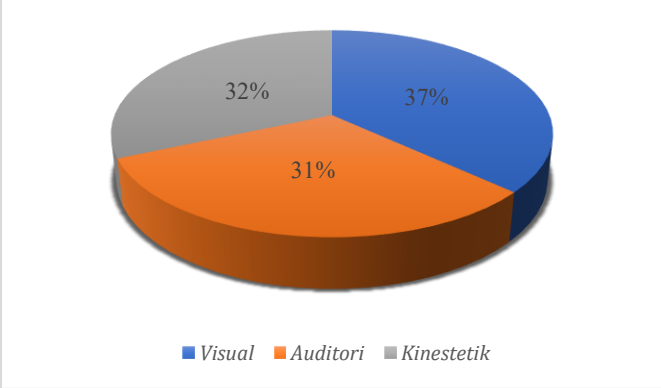

Figure 2. Results of students' learning style analysis

The chart above illustrates the distribution of students' learning styles based on the results of a non-cognitive diagnostic assessment. Three learning style categories were identified: visual (37%), kinesthetic (32%), and auditory (31%). The largest proportion of students demonstrated a preference for visual learning, indicating a tendency to process information more effectively through images, diagrams, and written text. The second-largest group preferred kinesthetic learning, suggesting they learn best through hands-on activities, movement, and physical engagement. Meanwhile, the auditory learners—comprising 31%—benefit more from verbal instructions, discussions, and audio-based materials.

These findings reveal a diverse range of learning preferences among students, with a slight dominance of visual style. This variation underscores the need for differentiated instructional strategies that can address each learning style to maximize student engagement and learning outcomes. Incorporating a balanced approach that integrates visual, kinesthetic, and auditory elements may help create a more inclusive and effective learning environment.

Design

In the design stage, researchers compiled an initial design of a differentiated teaching module that contained general information, learning objectives, learning style mapping, learning activities tailored to the learning styles of students, assessments, and reflections of students and teachers. The module is designed with a project-based learning approach that emphasizes the development of collaboration skills. In addition to modules, researchers also compiled research instruments in the form of validation sheets, teacher and learner practicality questionnaires, pretest and posttest questions, and observation sheets for collaboration skills.

Development

The development stage was carried out by compiling the initial product of the differentiated teaching module (product 1), which was then validated by two experts. Validation includes aspects of content, appearance, language, and conformity with differentiated learning principles. The validation results showed that the module was categorized as valid and feasible to use with minor revisions (view Table 5). The module was then revised according to the validator's suggestions to produce a final product (product 2) that was ready to be implemented.

Table 5. Expert Validation Results of Differentiated Teaching Module

	Expert Validation 1		Expert Validation 2
Total empirical score achieved	78		74
Expected total empirical score		92	
Percentage (%)	85%		80%
Average		83%	
Interpretation		Valid	

The development and validation process of the differentiated teaching module based on learning styles, involving expert validators, is a crucial step to ensure product quality. The development phase includes the assessment of product validity prior to implementation (Sari et al., 2022). Validation results indicate that the module achieved an average validity score of 83%, classified as valid.

These findings support the view of Lestari et al. (2024) emphasizing that the development of learning materials must be grounded in content validity and practicality to effectively address learners' needs and learning styles. Validation from experts, teachers, and students provides a strong foundation for asserting that this differentiated teaching module meets comprehensive instructional development standards.

Implementation

At the implementation stage, the differentiated teaching module was tested on students of class X AKL at SMK Negeri 1 Parigi. Learning was carried out in accordance with the steps in the differentiated module, and data collection was carried out through a practicality questionnaire, observations for skills, and tests to analyze the effectiveness of the differentiated teaching module. Teachers and learners gave positive responses to the use of the module (see Table 6 for teacher responses and Table 7 for learner responses) which was considered easy to understand, systematic, and provided space for active participation of learners, and the results of the effectiveness of Cohen's d effect size based on the pretest- posttest results of learners (view Table 8). During implementation, learners showed increased involvement in group discussions, task sharing, and other collaboration indicators (Table 9).

Table 6. Results of Practicality Response by Teachers

	Acquisition Score	Maximum Score	Percentage (%)
Project IPAS teacher 1	43		90%
Project IPAS teacher 2	42	48	88%
Project IPAS teacher 3	48		100%
Average			92%
Interpretation			Very Practical

Table 7. Results of Practicality Response by Learners

Indicator	Average Percentage
Teaching module components are presented coherently (systematically) and clearly	95%
The learning stages are clear and organized based on differentiated learning principles	93%
Learning activities provide opportunities for students to collaborate	98%
Differentiated learning activities make learners actively involved and able to organize known information	95%
Differentiated learning activities motivate learners in the learning process	98%
The assessment in the differentiated teaching module is clearly organized	90%
The time allocation provided is effective to be applied in learning	95%
Observation instruments are presented in accordance with the indicators of creativity	90%
Non-cognitive diagnostic assessments are clearly made	98%
Language used is in accordance with *EYD (ejaan yang disempurnakan)*	95%
Average	95%
Interpretation	Very Practical

The developed differentiated teaching module was implemented in an actual classroom setting for trial purposes. The practicality analysis, as evaluated by an observer (the Project IPAS subject teacher as see on Table

6), indicated a high level of practicality, with an average score of 92%, categorized as "very practical". This suggests that teachers involved in the trial found the module easy to use and effectively applicable within the context of Project IPAS learning.

Practicality was also assessed through student response questionnaires (see Table 7), which evaluated various indicators related to the module's usability. Overall, students' ratings were consistently high across all indicators, with an average practicality score of 95%, also interpreted as "very practical." These findings align with (Nahak et al., 2024), who emphasized that a systematic approach to module development contributes to practical and effective instructional tools.

Furthermore, analysis of the effectiveness of the developed module was carried out by applying Cohen's d formula to estimate the effect size of the intervention implemented through differentiated teaching modules. The effect size value is calculated based on a comparative analysis between the pretest and posttest results of students. The results of the analysis of the effectiveness test value regarding the differentiated teaching module obtained the value summarized in Table 8.

Table 8. Teaching Module Effectiveness Analysis Results

	n	Mean	Standard Deviation
Experiment	19	30.57	4.87
Control	19	27.57	6.08
Cohen's d			0.93
Interpretation			Large Effect

The results of the calculation using the Cohen's d Effect Size formula, showed a result of 0.93 which means that the differentiated teaching module has a very large effectiveness and is effectively used by students.

The effectiveness of a teaching module is not solely determined by its practicality, but also by its ability to facilitate meaningful learning. An effectiveness test was conducted to evaluate the impact of the differentiated teaching module developed in this study. The evaluation was based on pretest and posttest scores and the calculation of Cohen's d effect size between control and experimental groups, each consisting of 19 students.

In the experimental group, the average pretest-posttest score was 30.526, compared to 27.526 in the control group (see Table 8). The calculated effect size was 0.93, which is interpreted as a large effect, indicating that the module had a substantial and effective impact on student learning outcomes.

This finding aligns with previous studies highlighting the positive influence of differentiated instruction on learning quality and student engagement (Nurdin et al., 2025), as well as on the enhancement of students' critical and creative thinking skills (F. Lestari et al., 2024). Differentiated instruction has consistently shown to improve creativity, problem-solving, and metacognitive abilities—key competencies for 21st-century learners (Yunita et al., 2023).

Therefore, the implementation of the differentiated module in this study proves to be not only academically effective but also supportive of students' holistic development—addressing both cognitive and affective domains—aligned with the modern educational demand for more personalized and meaningful learning approaches.

Furthermore, students' collaboration skills are measured using collaboration instrument sheets that have been validated by validators and observed at experiment class learning each meeting with the results in Table 9.

Table 9. Results of Learner Collaboration Skills Analysis

Description	Class/Grade X AKL		
	Meeting 1	Meeting 2	Meeting 3
Total score obtained	236	305	345
Total maximum score			380
Average (%)	62%	80%	91%
Total average (%)			78%
Skill Criteria			Skilled

Based on the results of collaborative skill assessments using expert-validated instruments consistently applied throughout each learning session, there was a significant improvement in students' collaborative abilities. This progress was observed across three meetings, measured through average scores and distribution across five key indicators: responsibility, respect for others, contribution, work organization, and teamwork (Hidayati, 2019).

In the first session, the average collaboration score was 62%, which increased to 80% in the second session, and reached 91% in the third session. These results indicate that students were categorized as skillful in collaboration. Effectiveness analysis using Cohen's d yielded a value of 0.89, categorized as a large effect (Cohen, 1988), providing strong evidence that the implementation of the differentiated teaching module had a highly positive impact on students' collaborative skill development.

This improvement aligns with findings by Li (2025) who emphasized that collaborative learning enhances student engagement by promoting idea exchange, sharing, and understanding different perspectives. Similarly, Sidgi (2022) highlighted that collaborative learning not only improves academic achievement but also fosters essential social and communication skills. In such environments, students learn to cooperate, share

ideas, and solve problems together—skills that are critical for success in the modern workforce.

Furthermore, the results of the analysis of the effectiveness of the module for collaboration skills with Cohen's d effect size in the control and experimental classes can be seen in Table 10.

Table 10. Results of the Analysis of the Effectiveness of the Module for Collaboration Skills

	n	Mean	Standard Deviation
Experiment	19	28.69	4.36
Control	19	20.79	11.70
Cohen's d			0.89
Interpretation			Large Effect

The table above shows that the effectiveness test with the effect size Cohen's d obtained a value of 0.89 with a large effect interpretation of effectiveness. So that the results of the analysis of students' collaboration skills show that the use of differentiated teaching modules is very effective in improving students' collaboration skills.

Furthermore, the percentage comparison for each indicator on students' collaboration skills for each meeting in experimental class can be seen in the graph below:

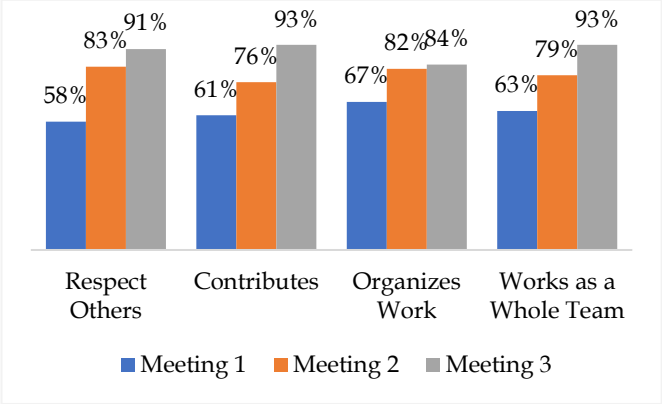

Figure 3. Graph of improvement of collaboration skills per indicator on experiment class

The graph above presents data on the five indicators of learners' collaboration skills observed in three different meetings. The graph shows an increase in the percentage of learners who showed collaboration skills from Meeting 1 to Meeting 3 in almost all aspects observed. Indicator-level analysis revealed that all aspects of collaboration skills showed consistent improvement over time. The responsibility indicator increased from 62% to 92%, reflecting a heightened individual awareness of roles and responsibilities within group work. Similarly, the respect for others indicator rose from 58% to 91%, indicating that a respectful and open communication environment developed positively throughout the learning process. The contribution indicator showed a particularly strong increase—from 61% to 93%—demonstrating that students became more active in sharing ideas and contributing toward group goals. Although the work organization indicator exhibited a more modest improvement (from 67% to 84%), it still indicated progress in students' managerial and planning abilities. Lastly, the working as a whole team indicator rose steadily from 63% to 93%, reflecting improved cohesion and coordination within group dynamics.

Overall, the data presented in this graph indicates a positive development in learners' collaboration skills over time. The increase in percentage in almost all aspects indicates that the intervention or learning process contributed to the improvement of learners' collaboration skills.

The percentage comparison for each indicator of student collaboration skills at each meeting in the control class (DPIB) can be seen in the graph below.

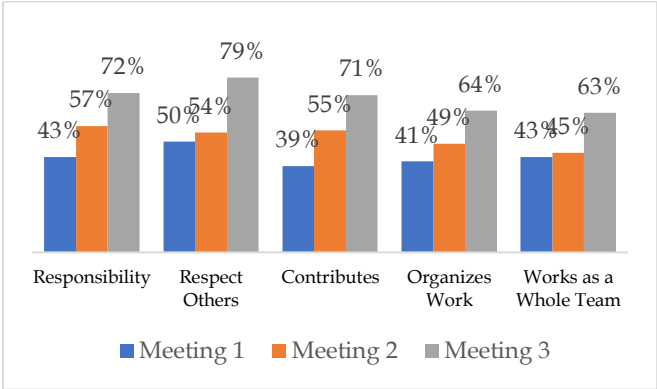

Figure 4. Graph of improvement of collaboration skill per indicator on control class

The control class also showed improvements. For the responsibility indicator, the percentage of students demonstrating responsibility increased from 43% in the first session to 57% in the second, reaching 72% in the third session. The most notable gain occurred between sessions two and three. The respect others indicator recorded the highest percentage among all aspects in the third session at 79%, rising from 50% in session one and 54% in session two. This suggests that students' ability to respect others developed more significantly compared to other indicators in the control class. In the contributes dimension, student participation rose from 39%—the lowest in the first session—to 55% in the second and reached 71% in the third, indicating a gradual increase in students' active contributions. The organizes work aspect improved from 41% in session one to 49% in session two, and 64% in session three. This was the slowest growth among all indicators, highlighting that organizational and planning skills

within group work require further attention. Lastly, for the works as a whole team indicator, the percentage increased slightly from 43% in session one to 45% in session two, and then more significantly to 63% in session three. The minimal increase in the early stage followed by a more noticeable improvement suggests delayed progress in team cohesion.

Overall, while all collaborative skill dimensions in the control class showed consistent improvements, the growth was incremental and lacked the significant acceleration often associated with targeted instructional interventions. By the third session, although scores were generally higher than in the first, several dimensions—such as organizes work and works as a whole team—remained below 65%, reinforcing the notion that without a deliberate instructional strategy to foster collaboration, progress tends to occur naturally but at a slower pace than in intervention-based settings. In general, the data in the graph shows an increase in all aspects of collaboration skills from Meeting 1 to Meeting 3. However, the increase can be described as moderate and gradual, without significant or rapid spikes, which is consistent with the characteristics of the control class that did not receive specific interventions to accelerate skill improvement.

The data obtained from the analysis of both the experimental and control classes indicate that the intervention or use of the differentiated teaching module is more effective in supporting the development of students' collaborative skills. The implications of these findings are significant for curriculum designers and educators, particularly in designing instructional interventions that focus not only on academic achievement but also on essential social competencies for the 21st century.

Evaluation

The evaluation phase, was carried out by evaluating the results of validation, responses from teachers and students through questionnaires, as well as analyzing the results of students' pretests and posttests as well as the results of the analysis of the skills measured. The success in developing differentiated teaching modules is measured based on feedback obtained from teachers and students through instruments or questionnaires that have been distributed, in addition, collaboration skill observations were analyzed using structured observation sheets. As stated by Teibang (2025) evaluation results serve as a feedback mechanism. The insights gained from this stage became the basis for refining the module to ensure its adaptability to educational dynamics and student needs. If there is a mismatch between the development results and the set objectives, the evaluation allows for revision. Furthermore, this evaluation becomes the basis for continuous improvement, so that the developed differentiated teaching module can continue to be refined along with the dynamics of education and the needs of students. Based on the results of the evaluation process, it can be concluded that the development of a differentiated teaching module based on students' learning styles in the IPAS project has been successful in enhancing students' collaboration skills.

Conclusion

Based on the results of the study, it can be concluded that the development of differentiated teaching modules based on students' learning styles in the Project IPAS subject proved to be feasible, practical, and effective for classroom use. The module achieved a validity score of 83%, falling into the valid category. Practicality was rated at 92% by teachers and 95% by students, indicating a high level of usability. Effectiveness analysis also demonstrated large effect sizes, with a Cohen's d of 0.93 for cognitive learning outcomes (posttest comparison between experimental and control classes), 0.89 for collaborative skills. The developed module successfully accommodates differentiated learning styles, resulting in more meaningful and learner-centered instruction. Furthermore, its use significantly improves students' collaboration skills, a key component of 21st-century competencies. Therefore, this differentiated teaching module serves as an innovative and research-based solution to support the implementation of differentiated instruction in schools.

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Author Contributions

Conceptualization, P.Y.B; methodology, P.Y.B, I.K.W, and L.T; validation, S.A., and R.; formal analysis, P.Y.B; investigation, P.Y.B.; data curation, P.Y.B; writing—original draft preparation, P.Y.B; writing—review and editing, P.Y.B, I.K.W, and L.T, S.A, R; All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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