Jupiter: Jurnal Pendidikan Terapan
Homepage : https://journal.diginus.id/jupiter/index
Email: jurnalpendidikanterapan@gmail.com

p-ISSN : 2985-3214; e-ISSN : 2964-3171
Jupiter, Vol. 4, No. 5, November 2026
Page 363-376

Development and Evaluation of Canva-Assisted North Sumatran Culture-Based Worksheets for Vocational Students' Mathematical Problem Solving

Rizka Fahruza Siregar[1*], Nova Riani[2], Asrindah Nasution[3], Rani Rahim[4]
[1,2]Universitas Pembinaan Masyarakat Indonesia, Medan, Indonesia
[3,4]Universitas Dharmawangsa, Medan, Indonesia

ARTICLE INFO

Article history:
Submitted: September 24, 2026
Final Revised: November 04, 2026
Accepted: November 09, 2026
Published: November 21, 2026

Keywords:
Student Worksheets (LKPD); Ethnomathematics; North Sumatran Culture; Canva; Mathematical Problem Solving; Vocational Education

ABSTRACT

Purpose: This study aimed to develop and evaluate Canva-assisted student worksheets (Lembar Kerja Peserta Didik/LKPD) based on North Sumatran culture to support Grade X vocational students' mathematical problem solving. **Methods:** The study used a research and development (R&D) approach with the 4-D model (Define, Design, Develop, Disseminate) of Thiagarajan, Semmel, and Semmel. It was conducted at SMK Negeri 5 Medan in the 2025/2026 academic year. Five validators (mathematics content, local culture, instructional media, and graphic design) assessed the product, a limited trial involved 9 students, and a field trial was carried out in one intact Grade X class (n = 36 students) with a pretest–posttest design. Data were collected with validation sheets, student response questionnaires, classroom observation, and a problem-solving test based on Polya's four stages, and were analyzed using mean validity scores, Aiken's V, item validity and reliability coefficints, percentages, classical mastery, N-Gain, and a pretest-posttest significance test with effect size. **Findings:** The LKPD was rated very valid (mean validity score 4.39 on a five-point scale) and practical (89.4%). In the field trial, classical mastery reached by 32 of 36 students (88.89%), mean problem-solving scores rose from 48.1 to 80.3 (N-Gain = 0.62, medium category), student activity averaged 86.1%, and 33 of 36 students (91.67%) responded positively. **Research Implications:** The LKPD met the preset criteria of validity, practicality, and effectiveness and is a feasible resource for vocational mathematics teachers. Because the study did not isolate the contribution of the cultural contexts, the Canva-based layout, or the Polya-based scaffolding, and reports no control-group comparison, the gains are descriptive evidence of improved scores after use rather than proof of a causal effect. **Originality:** The study documents a single validated worksheet that combines Karo, Batak, and Melayu cultural contexts, Canva-based visual layout, and Polya's four problem-solving stages for vocational mathematics classes.

Doi: https://doi.org/10.61255/jupiter.v4i5.2164

INTRODUCTION

Mathematics education in the 21st century demands students to master the 4C skills: Communication, Collaboration, Critical Thinking and Problem Solving, as well as Creativity and Innovation (Arifin, 2017); (Fitria, 2022) ; (Pedroso, 2023). Problem-solving is one of the most fundamental competencies in this paradigm because it enables students to apply mathematical knowledge to real-life situations systematically and meaningfully (Misu, 2014) ; (Tachie, 2019); (Khatimah, 2019). Despite its recognized importance, studies repeatedly report that Indonesian students' mathematical problem-solving ability remains low (Damianti, 2022); (Faqiroh, 2020); (Suparman, 2021); (Rahmi, 2021). Teacher-centered pedagogy and reliance on conventional methods are among the factors commonly linked to this situation, and recent development studies have responded by producing teaching materials that connect learning to students' own contexts (Kholifah, I. N., & Tegeh, I. M, 2024); (Setiawi, 2024).

In the Indonesian context, the development of problem-solving competence is also a curricular priority. The Merdeka Curriculum positions mathematical reasoning and the ability to solve contextual problems as core outcomes of mathematics learning at every level of schooling, including vocational high schools (Sekolah Menengah Kejuruan, SMK), where mathematics is expected to support students' technical and occupational

competencies. Nevertheless, vocational students may perceive mathematics as remote from their chosen field of study, which weakens motivation and leaves them reluctant to engage with non-routine tasks. Learning materials that present mathematical problems within contexts that students recognize therefore have practical value beyond the mathematics classroom itself.

At the research site, preliminary evidence points to the same difficulty. The front-end analysis at SMK Negeri 5 Medan found that mathematics instruction was predominantly teacher-centered, that the textbooks in use were not culturally contextualized, and that students engaged little with abstract problems detached from their experience. The pretest in this study gave a mean problem-solving score of 48.1, below the individual mastery standard of 65, with the lowest mean on the looking-back stage (41.3). The learner analysis further showed that students knew the cultural traditions of North Sumatran but had never used them as a basis for mathematical reasoning.

Polya's model of mathematical problem-solving, widely recognized in mathematics education, encompasses four sequential steps: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back (Christina, 2021); (Mariani, 2022); (Hasan, 2019). Student Worksheets (Lembar Kerja Peserta Didik/LKPD) that are designed in alignment with these problem-solving stages can serve as powerful scaffolding tools for developing students' competencies progressively.

One promising strategy for enhancing the contextual relevance of instructional materials is the integration of local culture into mathematics learning. Ethnomathematics, a field pioneered by (Ambrosio, 1985), examines the mathematical ideas embedded in cultural practices. Locally situated learning is argued to make abstract mathematical concepts more accessible and meaningful when students connect school mathematics to familiar cultural phenomena (Wijiningsih, 2017); (Zhang, 2019). In North Sumatran, the traditions of ethnic groups such as Batak, Karo, Melayu, and Minangkabau offer opportunities for mathematical contextualization, for example geometric patterns in traditional textiles, proportional reasoning in customary land measurement, and price modeling in trade conventions (Sitorus C. W., 2025); (Surya, 2020). Comparable ethnomathematics studies exist for other Indonesian communities, such as the Bugis (Rusli, F., & Azmidar, 2023).

The digital transformation of education has introduced new possibilities for developing visually engaging and interactive instructional materials. Canva, a free-to-use graphic design platform, has gained considerable traction in educational settings due to its accessibility, versatility, and professional-quality output (Jannah, 2023); (Pratama, 2023); (Meka, 2024). Canva enables educators to create LKPD that incorporate not only textual content but also rich visual elements illustrations, infographics, photographs, and interactive templates that significantly enhance visual appeal and student comprehension (Sihombing, 2024); (Musdalifah, 2024); (Syarifah, 2025); (Muna, 2023).

Theoretical Background

Polya (1945) described problem solving as a deliberate process rather than a matter of recalling a formula. In the first stage, understanding the problem, the solver identifies what is unknown, what data are given, and what conditions link them. The second stage, devising a plan, requires connecting the problem with previously learned concepts, considering related problems, and selecting a strategy such as drawing a diagram, looking for a pattern, or forming an equation. The third stage, carrying out the plan, involves executing the chosen strategy while checking each step. The fourth stage, looking back, invites the solver to examine the solution, verify the result, and reflect on whether the method could be applied elsewhere. Because each stage corresponds to a distinct cognitive demand, the model can be translated into observable indicators for assessment and into structured prompts within a worksheet (Christina, 2021; Mariani, 2022).

The pedagogical rationale for a scaffolded worksheet rests on socio-constructivist theory. Vygotsky (1978) argued that learners develop higher-order thinking within a zone of proximal development, the gap between what they can accomplish alone and what they can accomplish with appropriate support. Wood, Bruner, and Ross (1976) later used the term scaffolding to describe support that is gradually withdrawn as competence grows. A well-designed LKPD can serve as a written scaffold: its guiding questions, prompts, and step labels take over part of the regulatory role that a teacher would otherwise play, so that students can progress through unfamiliar problems with less direct instruction. This is particularly relevant in classes where a single teacher must support many students at once, and it is consistent with metacognitive accounts of problem solving in which explicit strategy prompts help learners monitor their own thinking (Tachie, 2019).

A second theoretical strand concerns cognitive load. Problem solving places heavy demands on working memory, and Sweller (1988) showed that unguided search for solutions can consume resources that would otherwise support the construction of schemas. Instructional materials should therefore direct attention to what is essential and avoid unnecessary processing. The cognitive theory of multimedia learning proposes that people learn more deeply when words and pictures are combined appropriately, when cues signal the organization of the material, and when related text and images are placed close together (Mayer, 2009). These principles offer a concrete rationale for using a design platform such as Canva: layout, color, icons, and infographic panels can be

used not as decoration but as instructional signals that segment a problem and mark each stage of the solution process.

Third, the cultural dimension of the worksheet is grounded in ethnomathematics and culturally relevant pedagogy. Ethnomathematics, pioneered by Ambrosio (1985), recognizes that mathematical ideas are embedded in the practices of cultural groups, such as counting, measuring, designing, and trading, and that these practices can serve as legitimate starting points for school mathematics. (Ladson-Billings, 1995) argued that culturally relevant pedagogy should help students achieve academic success while maintaining cultural competence. When students encounter a problem set in a familiar cultural setting, they can draw on prior knowledge and personal experience to make sense of the situation, which supports the activation of relevant schemas (Surya, 2020; Wijiningsih, 2017). Importantly, the cultural context must be more than a cosmetic backdrop. The mathematical structure of the problem should genuinely arise from the cultural artifact or practice, and the representation of the culture must be accurate and respectful, which is why cultural experts were included among the validators in the present study.

Finally, LKPD occupies a distinctive place among instructional materials in Indonesia. Unlike a textbook, which mainly presents content, a worksheet is an activity-oriented tool that directs students to investigate, construct, and reflect. Its quality therefore depends on the clarity of its instructions, the relevance of its tasks, and the alignment between its activities and the intended competencies. Previous development studies have shown that Canva can support these qualities by making it easy for teachers to combine text, illustrations, and layout templates into materials that can be printed or shared digitally (Musdalifah, 2024; Syarifah, 2025; Muna, 2023). What remains less clear is whether such materials can support problem solving in a structured way when they are also anchored in local culture.

Research Gap and Objectives

Previous studies have examined LKPD development with several instructional models, such as realistic mathematics education (Maulana, M., & Suparman, 2018); and problem-based learning (Pramudiyanti, 2023), ethnomathematics-based materials (Sitorus, 2025); (Rusli, F., & Azmidar, 2023), and Canva-assisted learning materials (Nurazizah, 2024); (Lubis, D. T. P., & Simbolon, N, 2023). Read together, these studies leave three issues open. First, the Canva-assisted studies address outcomes such as learning motivation (Lubis, D. T. P., & Simbolon, N, 2023) and mathematical literacy (Nurazizah, 2024) at the elementary or junior high school level, and they are not built on a local cultural context. Second, the ethnomathematics-based worksheets were developed around a single cultural setting, such as Istana Maimun in Medan (Sitorus C. W., 2025) or Bugis culture (Rusli, F., & Azmidar, 2023) and are not reported as Canva-based or organized stage by stage on Polya's framework. Third, research on Bima local culture and problem solving (Mariani, 2022) shows that culture-based learning can be connected to problem-solving ability, but it used a STEM model rather than a worksheet and was not set in a vocational mathematics class. Among the sources reviewed for this study, we did not find a study that develops a worksheet combining North Sumatran cultural contexts, Canva-based layout, and Polya's four stages for vocational students and reports its validity, practicality, and stage-level learning outcomes together. The novelty claimed here is therefore a specific combination and its documentation, not the invention of any single component.

Based on this gap, the study was guided by two research questions: (1) How can local culture-based LKPD assisted by Canva be developed to meet the criteria of validity, practicality, and effectiveness? (2) How did the mathematical problem-solving ability of Grade X vocational students change, overall and on each of Polya's four stages, after they used the LKPD?

Accordingly, this study pursued three objectives: (1) to describe the process of developing local culture-based LKPD assisted by Canva through the 4-D model; (2) to determine the validity, practicality, and effectiveness of the resulting product; and (3) to examine changes in students' mathematical problem-solving ability, both overall and for each of Polya's four stages. The distinctive contributions are (a) an explicit link between three North Sumatran cultural practices and the mathematical topics they were used to teach, (b) activities sequenced to Polya's stages with Canva-based visual cues for each stage, and (c) stage-level outcome data. Theoretically, the study documents how ethnomathematics, multimedia design principles, and a problem-solving framework can be combined in one instructional material and how that material performs on validity, practicality, and learning outcomes. Practically, it offers mathematics teachers, particularly in vocational schools, a replicable model for producing contextual worksheets with freely accessible tools, and it offers curriculum developers preliminary evidence on the use of local culture as a context for mathematical problem solving.

METHOD

This study employed a developmental research design, specifically the 4-D model developed by (Thiagarajan, 1974). The 4-D model comprises four sequential phases: Define, Design, Develop, and Disseminate. This model

was selected for its systematic and cyclical nature, ensuring that the developed product undergoes rigorous validation and iterative revision before full-scale implementation.

The 4-D model was chosen for three reasons. First, it separates the front-end analysis of learners and curriculum from the design of the product, which helps ensure that the LKPD responds to real classroom needs rather than to assumptions. Second, it accommodates expert judgment and small-scale trials before the product reaches a full class, allowing problems in content, cultural representation, or layout to be corrected early. Third, its phases yield clearly identifiable drafts (Draft I to Draft IV in this study), which makes the evolution of the product traceable. The Disseminate phase, which some studies treat only as a recommendation for future work, was carried out here through a teacher forum.

The study was conducted at SMK Negeri 5 Medan, North Sumatran, Indonesia, during the 2025/2026 academic year. The participants were Grade X students. Random sampling of individual students was not used. The school was selected purposively because the front-end analysis identified the instructional problems described above at this school, and the field-trial class was one intact Grade X class, the class is selected based on a recommendation from the mathematics teacher. Because all 36 students of this class took part, no further sampling was done within the class, and students were not randomly assigned to conditions. The limited trial involved 9 students who were chosen by the mathematics teacher to represent low, medium, and high ability levels and who were not part of the field trial.

The field trial involved one intact class of n = 36 students, taught by the regular mathematics teacher across four learning sessions of 45 minutes each. The effectiveness trial used a pretest–posttest design: the same problem-solving test was given before the first session and after the fourth session. Because a design without a comparison group cannot control for maturation, familiarity with the test, or teacher effects, the learning-outcome results are interpreted descriptively. Product validation was carried out by five validators: two mathematics content experts, one local culture expert, one instructional media expert, and one graphic design expert, chosen on the basis of qualification criteria such as degree, field, and experience. Validators rated the dimensions that matched their expertise: content experts rated mathematical content and alignment with problem-solving indicators, culture experts rated local cultural authenticity, and media and graphic design experts rated instructional design and visual media.

Data were collected from several sources across the development process. Expert comments and classroom observation notes were used mainly to revise the product between drafts, whereas validation scores, questionnaire scores, and test scores were analyzed quantitatively to judge whether the product met the criteria of validity, practicality, and effectiveness. The four learning sessions drew on the cultural contexts and mathematical topics identified during the define and design phases, and every session followed the same six-component worksheet structure. A common structure across sessions allowed students to become familiar with the routine of the worksheet, which is important for a scaffold intended to be used independently.

Development Phases

Define Phase

This phase involved five analytical activities: (1) front-end analysis to identify instructional problems; (2) learner analysis to understand students' prior knowledge, learning styles, and cultural familiarity; (3) concept analysis to map essential mathematical content; (4) task analysis to sequence learning activities; and (5) specifying learning objectives aligned with Polya's problem-solving stages.

Design Phase

Based on the define phase outcomes, the research team designed the LKPD framework. This included selecting appropriate North Sumatran cultural contexts (e.g., Karo ulos weaving patterns for geometric sequences and series, Batak customary land measurement for proportional calculations, and Melayu trade conventions for price modeling), drafting problem-solving indicators aligned with Polya's model, and creating visual layouts using Canva's templates, cultural illustrations, and infographic elements. The initial product at this stage was Draft I.

Develop Phase

Draft I was submitted for expert validation by a panel of five validators covering mathematics content, local culture authenticity, instructional media design, and graphic design. Feedback was systematically incorporated to produce Draft II. A limited trial was then conducted with 9 students, and responses were analyzed to generate Draft III. Following a field trial (Draft IV), effectiveness analysis was completed. The final product-a validated, practical, and effective LKPD was produced after multiple revision cycles.

Disseminate Phase

The finalized LKPD was packaged and disseminated to mathematics teachers through the MGMP (Musyawarah Guru Mata Pelajaran) forum, and findings were prepared for publication in a nationally accredited journal.

Four instruments were used: (1) validation sheets to assess content validity, cultural authenticity, media quality, and alignment with problem-solving indicators; (2) student response questionnaires measuring ease of use, visual appeal, cultural relevance, and motivational impact; (3) a classroom observation sheet for learning implementation and student activity (two observers); and (4) a mathematical problem-solving test (pretest and posttest) designed according to Polya's four-step framework, covering understanding the problem, planning, execution, and reflection. The mathematical problem-solving test consisted of four questions, and every question was scored on all four Polya indicators.

The validation sheets were organized around the five dimensions later reported in Table 1: mathematical content, local cultural authenticity, instructional design, visual media and Canva design, and alignment with problem-solving indicators. Each dimension was rated by the validators on the five-point scale described below, and validators could also provide written suggestions for revision. The student response questionnaire captured four aspects of the students' experience, namely ease of use, visual appeal, cultural relevance, and motivational impact, so that the product could be evaluated from the perspective of its users as well as its designers. The problem-solving test was constructed around Polya's framework so that student answers could be scored separately for each of the four stages. This design made it possible to report gains at the level of individual indicators (Table 5) rather than only as a single overall score, and to identify which stages of problem solving benefited most from the worksheets. Each stage was scored with the following indicators, derived from (Polya, 1945): understanding the problem (identifying the unknown, the given data, and the conditions); planning the solution (connecting the problem with prior concepts and choosing a strategy); executing the plan (carrying out the chosen strategy accurately and checking each step); and looking back (verifying the result and reflecting on the method). Each indicator of each question was scored on a 0-4 scale using the descriptors, which gave a maximum of 16 points per question and 64 points per test, the total was converted to a 0-100 score (total score divided by 64 and multiplied by 100). A full score was given when the student correctly identified the unknown, the given data, and the conditions (understanding); proposed a strategy that fits both the cultural situation and the mathematical concept involved (planning); carried out the strategy without calculation or procedural errors and checked intermediate steps (executing); and verified the answer and stated a conclusion in the context of the cultural problem (looking back). Partial scores were given for incomplete or partly correct responses, and no score for blank or irrelevant ones.

Data Analysis

Validity Analysis

Expert validators rated each LKPD component on a 1–5 Likert scale. The average total validity (RTVBA) was computed across all criteria and classified as: very valid ($4 \leq \text{RTVBA} \leq 5$), valid ($3 \leq \text{RTVBA} < 4$), less valid ($2 \leq \text{RTVBA} < 3$), or invalid ($1 \leq \text{RTVBA} < 2$) (Panggabean, 2020). Agreement among validators was examined using Aiken's V, which converts each validator's rating into a score relative to the lowest possible rating, sums these scores across validators, and divides by the maximum possible sum, so that values closer to 1 indicate stronger agreement (Aiken, 1985). V values of at least 0.80 were interpreted as adequate agreement. The same validators also judged the content validity of the problem-solving test, namely the alignment of each question with Polyas's indicators and with the cultural context.

Practicality Analysis

Practicality was determined by (a) expert and practitioner judgment that the LKPD was usable, and (b) observation of learning implementation. Experts and practitioners rated usability and clarity with a rating-scale checklist, and implementation was observed with a sheet recording whether each planned learning step was carried out; scores were converted to percentages as described below.

Effectiveness Analysis

Effectiveness criteria included: (a) minimum 65% individual mastery and 85% classical mastery of learning outcomes; (b) student learning activity scores; and (c) positive student responses exceeding the set threshold.

Test Analysis

Item validity was computed using the Pearson product-moment correlation coefficient (rxy), with interpretations ranging from very low (0.00–0.20) to very high (0.80–1.00). Reliability was assessed using Cronbach's alpha (α), with the same interpretive range. The test was tried out on a separate group of 36 Grade X students who did not take part in the field trial. The score on each question was correlated with the total score, and a question was considered valid when rxy exceeded the critical value for n = 36 (r = 0.329 at $\alpha = 0.05$, df = 34); reliability was judged acceptable when $\alpha \geq 0.70$. N-Gain scores were used to measure learning improvement from pretest to posttest (Hake, 1998); (Lubis, 2024). Differences between pretest and posttest scores were tested with a paired-samples t-test when the score differences were normally distributed (checked with the Shapiro–Wilk test) and the Wilcoxon signed-rank test otherwise, and effect size was reported as Cohen's d (Cohen, 1988) about 0.2 small, 0.5

medium, 0.8 large) with a 95% confidence interval. The tests were applied to the overall score and to each Polya indicator, with $\alpha = 0.05$.

The quantitative criteria were operationalized as follows. The average total validity (RTVBA) was the mean of all validators' ratings across all criteria. Practicality, student activity, and positive response were each expressed as a percentage, calculated as the total score obtained divided by the maximum possible score and multiplied by 100%. Specify the maximum possible score (denominator) used for praticality, student activity, and the questionnaire score of each student. Practicality was compared with a 75% threshold; the thresholds for student activity and positive response were 82%. For the questionnaire, a student was counted as responding positively when his or her questionnaire score reached the positive category, defined as 84%, and the positive response rate was the number of such students divided by the total number of students. A student was considered to have reached individual mastery when the score was at least 65, and classical mastery was the percentage of students who reached individual mastery, which had to be at least 85%. With n = 36, this criterion required at least 32 students (88.89%) to reach mastery, because 30 students correspond to 8.33%. The positive response rate can likewise take only values tjat are multiples of 1/36 (for example, 88.9% for 32 students and 91.7% for 33 students). The N-Gain was calculated as the posttest score minus the pretest score, divided by the maximum possible score (100) minus the pretest score, and was interpreted using the classification of Hake (1998): high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), and low ($g < 0.30$); no further subcategories were used. The N-Gain values reported in Table 2 were computed from the mean pretest and posttest scores of each indicator. Internal consistency of the test was evaluated with Cronbach's alpha (Cronbach, 1951).

RESULTS

Define Phase Outcomes

Front-end analysis revealed that current mathematics instruction at SMK Negeri 5 Medan remains predominantly teacher-centered, relying on standard textbooks that lack cultural contextualization. Students showed low engagement with abstract problems disconnected from their lived experiences. Learner analysis indicated that while students had general familiarity with North Sumatran cultural traditions, they had never encountered these within a mathematics learning context. Concept analysis identified statistics, sequences, and geometry as the most suitable topics for cultural integration during the study period.

These findings established the need for the product. Three conditions stood out: instruction that was largely teacher-centered, textbooks that were culturally neutral, and low student engagement with abstract problems. Together they pointed to the need for materials that give students an active role, connect mathematical tasks to lived experience, and guide students explicitly through the stages of problem solving. The learner analysis was particularly informative. Students already knew the cultural traditions of their region but had never used them as a basis for mathematical reasoning, which suggests that their cultural knowledge was an untapped resource for learning rather than an obstacle to it.

Design Phase Outcomes

The LKPD framework was structured with six components per session: (1) title and cultural theme introduction; (2) usage instructions; (3) core competencies and learning objectives; (4) cultural context narrative with visual illustrations; (5) guided problem-solving activities organized by Polya's steps; and (6) reflective review questions. Cultural contexts included: Karo traditional ulos (weaving) patterns linked to geometric sequences and series; proportional calculations in the measurement of land in Batak customary practices; and price modeling using traditional Melayu trade conventions. In each context, the mathematical structure of the task was meant to come from the cultural artifact or practice itself and not to serve only as a backdrop. As an illustration, in the Karo ulos context the repeated motifs along a woven band were treated as terms of a sequence, so that finding the number of motifs in a later row required identifying the common ratio and applying the formula for a geometric sequence or series. In the Batak customary land measurement context, plot dimensions given in traditional units were converted and compared as ratios. In the Melayu trade context, the prices of goods at different quantities were modeled as a function of quantity.

Canva was used to design visually rich layouts featuring hand-curated photographs of cultural artifacts, traditional architectural illustrations, color schemes inspired by regional textiles, and infographic panels guiding students through each problem-solving step. The result was Draft I, a visually structured worksheet. Each of the four sessions followed the same six-component structure, which gave students a predictable routine. Within the guided activities, prompts were sequenced to mirror Polya's stages: students first extracted the known and unknown information from the cultural narrative, then selected a strategy, carried out the calculations, and finally re-examined their answers in light of the cultural context. Visual design decisions served this structure. Color schemes drawn from regional textiles gave the worksheets a coherent identity, infographic panels marked the four stages, and photographs and illustrations of cultural artifacts anchored each problem in a recognizable setting.

Draft I thus combined three layers of design, cultural, mathematical, and visual, that were intended to work together rather than independently.

Develop Phase Outcomes

Validity Results

Draft I was evaluated by five validators. Table 1 presents the mean scores per validation dimension.

Table 1. Expert Validation Results of the Local Culture-Based LKPD

Nu.	Validation Dimension	Average Score	Category
1	Content Validity (Mathematics)	4.42	Very Valid
2	Local Cultural Authenticity	4.35	Very Valid
3	Instructional Design Quality	4.28	Very Valid
4	Visual Media & Canva Design	4.51	Very Valid
5	Alignment with Problem-Solving Indicators	4.38	Very Valid
	Overall Average (RTVBA)	**4.39**	**Very Valid**

The overall validity score of RTVBA = 4.39 falls within the very valid range ($4 \leq RTVBA \leq 5$), indicating that the LKPD is suitable for use as a learning material. Validators particularly commended the authenticity of the cultural context integration and the quality of the Canva-produced visuals. Minor revisions were requested on mathematical notation and on the clarity of the problem-solving step instructions. The validators' comments and the revisions made in response are documentes in Table 3. Draft III was produced from students' responses in the limited trial, and Draft IV after the field trial. Agreement among the five validator was examined with Aiken's V (Table 2). V ranged from 0.83 to 0.90 across the five dimensions and was 0.86 for the instrument as a whole, so agreement met the 0.80 cut-off in every dimension.

Table 2. Aiken's V of the Expert Validation Results

Nu.	Validation Dimension	Aiken's V	Category
1	Content Validity (Mathematics)	0.85	Valid
2	Local Cultural Authenticity	0.88	Valid
3	Instructional Design Quality	0.83	Valid
4	Visual Media & Canva Design	0.90	Valid
5	Alignment with Problem-Solving Indicators	0.86	Valid
	Overall	**0.86**	**Valid**

A closer look at Table 1 shows that the visual media and Canva design dimension received the highest average score (4.51), while instructional design quality received the lowest (4.28). The difference between the highest and lowest dimensions was only 0.23, and every dimension fell in the very valid category. This indicates a consistently high evaluation across dimensions rather than a strong result on one dimension masking weakness in another. The minor revisions requested by the validators, which concerned mathematical notation and the clarity of step instructions, were incorporated into Draft II. They suggest that the wording of instructions, rather than the content or the visuals, offered the greatest room for improvement. Table 3 documents the feedback collected at each stage of development and the revisions made to the product.

Table 3. Feedback and Corresponding Revisions of the LKPD

Draft	Source of Feedback	Feedback Received	Revision Made
I → II	Expect validation (five validators)	Minor correction to mathematical notation	The multiplication sign "x" was replaced with "×" in Activities 2 and 3, and the fraction format on page 5 was standardized to a proper fraction layout.
I → II	Expert validation (five validators)	Step instruction needed clearer wording	Long instructions were split into numbered steps, and ambiguous verbs such as "look at" were replaced with specific ones such as "calculate" and "write down".
II → III	Limited trial (9 students)	Students found the font too small and were unsure where to write their answers	Font size was increased from 10 pt to 12 pt, and answer boxes with clear labels were added beneath each problem.

Draft	Source of Feedback	Feedback Received	Revision Made
III → IV	Field trial (observation and teacher feedback)	The teacher suggested a shorter, more concise context story, and some students needed more time for the final problem	The context story was shortened by about a third, and an estimated time allocation was added to each activity.

Instrument Validity and Reliability

The problem-solving test was tried out on 36 students outside the field trial before it was used. Table 4 reports the correlation between the score on each question and the total score, together with Cronbach's alpha. All four questions were valid (rxy > 0.329) and the test was reliable (α = 0.78, high category). Content validity of the test, judged by two mathematics education lecturers and one mathematics teacher, is described in the Method section.

Table 4. Validity and Reliability of the Problem-Solving Test (Try-Out, n = 36)

Question	rxy	r critical (n = 36)	Decision / category
Question 1	0.62	0.329	Valid
Question 2	0.71	0.329	Valid
Question 3	0.58	0.329	Valid
Question 4	0.67	0.329	Valid
Cronbach's alpha (α)	**0.78**	**-**	**Reliable (high)**

Practicality Results

Following revision to Draft II, a limited trial was conducted. All five expert assessors unanimously affirmed the LKPD's practical usability. Classroom observation during both the limited trial and the initial field trial showed smooth implementation, with students able to follow the instructions independently. The LKPD achieved a practicality rating of 89.4%, exceeding the 75% threshold for practical materials. Teachers reported that the structured, step-by-step format of the problem-solving activities reduced the need for excessive teacher guidance.

The practicality score of 89.4% exceeded the 75% threshold by 14.4 percentage points. Two sources of evidence pointed in the same direction: the judgment of experts and practitioners, and observation of the classroom. That students were able to follow the instructions independently is noteworthy, because it indicates that the wording and layout of the worksheet were clear enough to function without constant explanation from the teacher. This is what a scaffolding tool is supposed to do, and it was echoed in the teachers' report that the structured, step-by-step format reduced the need for excessive guidance.

Effectiveness Results

After four implementation sessions, the pretest and posttest scores of the field-trial class (n = 36) were analyzed. Table 5 presents the summary of learning outcomes.

Table 5. Pretest and Posttest Scores of Mathematical Problem-Solving Ability

Indicator	Pretest Mean	Posttest Mean	N-Gain	Category
Understanding the Problem	52.4	81.7	0.62	Medium
Planning the Solution	48.6	79.3	0.60	Medium
Executing the Plan	50.1	83.4	0.67	Medium
Looking Back (Reflection)	41.3	76.8	0.60	Medium
Overall Problem-Solving	48.1	80.3	0.62	Medium

The overall N-Gain of 0.62 falls in the medium category of (Hake, 1998), in the upper part of that range. 32 of 36 students (88.89%) reached the individual mastery standard of 65, so calssical mastery met the 85% effectiveness threshold, which required at least 31 students. Student activity scores averaged 86.1% and 33 of 36 students (91.67%) gave positive responses to the LKPD. The largest N-Gain was found for Executing the Plan (0.67); the step-by-step visual layout may have contributed to this, but the present design cannot confirm that explanation. N-Gain values in Table 5 were recalculated from the stated means with a maximum score of 100.

A closer reading of table 5 reveals several patterns. First, improvement occurred on every indicator: the overall mean rose from 48.1 to 80.3, a gain of 32.2 points, and no indicator finished below 76.8 at the posttest. Second, the four stages started from different baselines. Looking Back was the weakest at the pretest (41.3), followed by Planning the Solution (48.6), Executing the Plan (50.1), and Understanding the Problem (52.4). Third, the pattern of gains differs depending on whether raw differences or N-Gain values are considered. In raw terms, Looking Back improved the most (35.5 points) and Understanding the Problem the least (29.3 points). In N-Gain terms, which take into account the room for improvement available to each indicator, Executing the Plan showed

the highest value (0.67), while Planning the Solution and Looking Back showed the lowest (0.60 each). All N-Gain values fall in the medium category.

Because the study used a single group, the pretest-posttest differences were tested with a paired-samples *t*-test, chosen after a Shapiro-Wilk test of the difference scores indicated that the data were normally distributed ($W = 0.972$, $p = .463$). Table 6 shows that the overall difference was statistically significant ($t(35) = 20.13$, $p < .001$), with a very large effect size ($d = 3.35$, 95% CI [2.51, 4.19]). The tests for the four Polya indicators are reported in the same table, and all of them were also significant.

Table 6. Tests of Pretest-Posttest Differences (n = 36)

Indicator	Pretest M (SD)	Posttest M (SD)	Test statistic	*p*	Cohen's *d* [95% CI]
Understanding the Problem	52.4 (9.8)	81.7 (8.1)	17.23	< .001	2.87 [2.13, 3.61]
Planning the Solution	48.6 (10.4)	79.3 (8.9)	16.02	< .001	2.67 [1.97, 3.37]
Executing the Plan	50.1 (10.1)	83.4 (7.9)	18.50	< .001	3.08 [2.30, 3.87]
Looking Back (Reflection)	41.3 (11.6)	76.8 (9.7)	16.26	< .001	2.71 [2.00, 3.42]
Overall Problem-Solving	48.1 (8.7)	80.3 (6.9)	20.13	< .001	3.35 [2.51, 4.19]

Note. Cohen's d is d_z (mean difference divided by the SD of the differences)

The other effectiveness criteria are reported below with the corrected counts. 32 of 36 students (88.89%) reached in the individual mastery standard of 65. The student activity score averaged 86.1%, and 33 of 36 students (91.7%) responded positively to the LKPD. Table 7 brings together the results for the three quality criteria of validity, practicality, and effectiveness

Table 7. Summary of Product Quality Criteria for the Local Culture-Based LKPD

Nu.	Quality Criterion	Result	Benchmark and Status
1	Validity (expert validation)	RTVBA = 4.39	Very valid ($4 \leq$ RTVBA ≤ 5); met
2	Practicality	89.4%	Above the 75% threshold; met
3	Effectiveness: classical mastery	88.89%	Met against the 85% threshold (at least 32 of 36 students)
4	Effectiveness: N-Gain	0.62	Medium category ($0.30 \leq g < 0.70$)

Taken together, the results indicate that the LKPD met the preset criteria of a good instructional product on all three dimensions. It was judged suitable by experts, it could be used smoothly in the classroom, and it was accompanied by substantial improvement in students' problem-solving scores. The consistency between expert-based, observation-based, and student-based evidence supports the conclusion that the product is of good quality. It does not by itself establish that the worksheets caused the score gains, because the design has no comparison group.

DISCUSSION

The validity findings of this study are in the same direction as previous research on culturally situated instructional materials in mathematics education. (Sitorus, 2025) reported high validity scores for PBL-based LKPD built around the ethnomathematics of Istana Maimun, and (Nurazizah, 2024) reported valid Canva-assisted worksheets for mathematical literacy. Differences in school level, topic, and instruments limit direct comparison with those studies. What the present study adds is the combination of North Sumatran cultural contexts, Canva-based layout, and Polya's stages in one worksheet for vocational students, together with stage-level outcome data.

The high validity scores across all five dimensions deserve interpretation beyond the numbers. Validation by experts from different domains is a demanding test for a product of this kind, because a worksheet can be mathematically sound yet culturally inaccurate, or culturally rich yet poorly organized instructionally. That all dimensions were rated very valid, with only minor revisions requested concerning notation and step instructions, suggests that drawing on mathematical content, cultural knowledge, and media design at the same time may have helped avoid these common weaknesses. It is also consistent with the view that cultural authenticity and mathematical rigor are not competing requirements. Expert validation, however, speaks to the quality of the product, not to its effect on learning.

The effectiveness results are consistent with the findings of (Angraini, L. M., & Fitri, Y. C, 2023) on the positive effect of interactive multimedia-based learning on problem-solving ability, although the two studies differ in design and intervention, so the comparison is indicative only. (Polya, 1945) four-step model was the structural backbone of each LKPD activity, which may have given students a consistent scaffold (Wood, 1976). Explanations that the scaffold reduced cognitive load or that the cultural contexts activated students' existing schemas (Surya,

2020); (Sweller, 1988) are theoretically grounded interpretations; neither cognitive load nor schema activation was measured in this study, so they are not findings.

The stage-by-stage results offer further insight into how the LKPD may have worked. For Understanding the Problem, the cultural narrative that opens each activity may have helped students visualize the situation, since the setting was familiar and needed little explanation. When a situation is recognizable, students can devote more attention to identifying what is known and what is asked, rather than to decoding an unfamiliar scenario. Planning the Solution had an N-Gain (0.60) tied for the lowest with Looking Back, so the improvement was smaller relative to the room available. Selecting a strategy requires students to connect the problem with previously learned concepts and to choose among alternatives (Polya, 1945), and this is generally the most demanding of the four stages. The smaller gain may also point to limits of the worksheet itself: if the planning prompts mainly asked students to name a strategy rather than to compare alternatives, they may not have supported strategy selection enough. Support such as tasks in which students compare two possible strategies before choosing one could be added in a later revision. Because this study did not analyze students' written planning responses, this explanation remains tentative; such an analysis is proposed for the next revision cycle.

For Executing the Plan, the highest N-Gain (0.67) is consistent with the explanation that the step-by-step visual layout made procedures easier to follow and to check. This explanation remains an interpretation, because the present design does not isolate the contribution of visual scaffolding from the other features of the LKPD. The Looking Back indicator deserves special attention. It had the lowest pretest mean (41.3) and the largest raw gain (35.5 points). Polya (1945) observed that even capable students tend to regard a problem as finished as soon as an answer has been obtained, and the low baseline may indicate that students in this study rarely verified or reflected on their solutions. Because every session ended with reflective review questions, the worksheet made this stage an explicit and expected part of the task. The improvement is consistent with the possibility that reflection can be taught when it is built into the materials rather than left to students' initiative, although it cannot be separated from effects such as familiarity with the test, and the posttest mean for this stage (76.8) remained the lowest of the four.

The role of Canva in this development process deserves comment. (Rahmasari, E. A., & Yogananti, A. F, 2021) reported high usability ratings for Canva among design students, which is consistent with the student responses in this study, where 91.67% responded positively to the LKPD. The questionnaire covered ease of use, visual appeal, cultural relevance, and motivational impact, but results are not reported separately for each aspect, so this study cannot say whether the visual design, the cultural content, or the step structure drove the positive responses, nor that it changed students' motivation or their view of mathematics.

The contribution of Canva should be understood in terms of instructional design rather than aesthetics alone. According to the principles of multimedia learning (Mayer, 2009), illustrations are beneficial when they are integrated with text and support the learner's selection and organization of information. In the present LKPD, infographic panels marked each problem-solving step, photographs and illustrations were placed alongside the relevant part of the narrative, and consistent color schemes distinguished the sections of the worksheet. These features may have reduced extraneous cognitive load (Mayer, 2009); (Sweller, 1988) by helping students locate the information and instructions they needed, but this is a design rationale and not an empirical result. It is also important that Canva is freely accessible and easy to learn, so the approach does not depend on specialized software or design skills. For teachers in vocational schools with limited budgets and time, this practicality may be as important as the pedagogical benefits, because it determines whether the approach can be sustained and reproduced beyond a research project.

Compared with the worksheets based on realistic mathematics education (Maulana, M., & Suparman, 2018) and on problem-based learning (Pramudiyanti, 2023), the present LKPD differs in three respects: (1) explicit use of North Sumatran cultural contexts; (2) Canva-based visual layout; and (3) alignment of every activity with Polya's problem-solving framework. Because these features were implemented together, the study provides no evidence about the contribution of each one, and its novelty lies in the combination and its documentation.

Alternative explanations for the observed gains must also be considered. The pretest–posttest improvement may partly reflect familiarity with the test, maturation over the implementation period, additional teacher support during the four sessions, or the novelty of a visually attractive worksheet. Without a comparison group these explanations cannot be ruled out, which is why the results are presented as evidence of product quality and of improved scores after use, and not as proof that the worksheets caused the improvement. Statistical significance and effect size indicate how large the pretest-posttest difference is, not what produced it.

Several implications follow from these findings. For teachers, the results suggest that everyday cultural knowledge can be turned into mathematical tasks, provided that the mathematics is structurally connected to the cultural artifact or practice. The dissemination of the LKPD through the MGMP forum is a practical route by which such materials can be shared, adapted, and improved by teachers who know their own students' cultural contexts. For curriculum developers and school leaders, the results offer preliminary support for using local culture as a resource for contextual learning. For vocational schools in particular, culturally grounded tasks may help

bridge students' identities as members of local communities with their identities as learners of mathematics. The study also shows that an established problem-solving framework can serve as the organizing structure of a worksheet, since the Polya stages gave both the designers and the students a shared vocabulary for what it means to solve a problem.

At the same time, the use of culture in mathematics learning carries a responsibility to represent it accurately. Cultural elements should not be reduced to decoration or stereotype. In this study cultural authenticity was checked through expert validation (mean score 4.35), but the study did not examine whether the cultural practices generated the mathematical structure of the tasks in students' actual work. Authenticity was assessed by the local culture experts among the validators, who judged whether cultural artifacts, terms, and practices were represented accurately and respectfully; it was one of the five validation dimensions (Table 1). Future developers should involve community members and cultural practitioners so that materials reflect living traditions rather than simplified versions of them.

Limitations and Suggestions for Further Research

Several limitations should be acknowledged. First, the study was conducted in a single school, with one field-trial class and across only four learning sessions, so the results cannot be generalized to other schools, grade levels, or regions without further testing. Second, the study used a pretest–posttest design without a comparison group or randomization, so the score gains cannot be attributed to the product; maturation, familiarity with the test, and the teacher's own instructional skill may have contributed. Third, the cultural contexts, the Canva-based layout, and the Polya-based scaffolding were implemented together, so the contribution of each cannot be separated. Fourth, the student response questionnaire and the activity scores reflect the perceptions of students and observers, which may be affected by the novelty of a visually attractive worksheet, and neither cognitive load nor motivation was measured directly. Fifth, the problem-solving test contained only four questions, so content coverage and the precision of stage-level scores are limited, and reliability estimates based on four questions should be interpreted cautiously. Sixth, the study did not measure retention, so it remains unknown whether the improvement persists after the intervention ends. Finally, the cultural contexts were limited to three ethnic traditions of North Sumatra, and the LKPD was developed for a specific set of topics.

Future research should first evaluate the product with a comparison group, ideally with random assignment or matched classes, and with between-group statistics and effect sizes. Studies involving multiple schools and longer implementation periods would strengthen the generalizability of the findings, and a delayed posttest would show whether gains are retained. Experimental designs that vary one component at a time, namely cultural context, Canva-based visual design, and Polya-structured scaffolding, would help determine which component contributes most to any improvement. Researchers could also extend the approach to other cultural groups in Indonesia, to other mathematical topics, and to digital worksheets that provide immediate feedback, while attending to equitable access to devices and printing facilities. Qualitative studies of students' problem-solving processes, such as think-aloud protocols or analysis of written work, would provide a richer account of how cultural context and visual scaffolding influence students' reasoning.

CONCLUSION

This study developed Canva-assisted student worksheets (LKPD) based on North Sumatran culture for Grade X vocational students at SMK Negeri 5 Medan, using the 4-D model. The product met the preset criteria for validity (mean score 4.39, very valid), practicality (89.4%), and effectiveness (classical mastery 32 of 36 students (88.89%), student activity 86.1%, and positive responses 33 of 36 students (91.67%)). Mean problem-solving scores rose from 48.1 to 80.3 (N-Gain = 0.62, medium category), with gains on all four of Polya's stages: the largest N-Gain was on Executing the Plan (0.67) and the smallest on Planning the Solution and Looking Back (0.60 each).

These results indicate that combining Karo, Batak, and Melayu cultural contexts, a Canva-based layout, and Polya-structured activities is a feasible and well-regarded design for vocational mathematics worksheets. They do not show which of these components produced the score gains, or that the worksheets caused the gains, because the study had no comparison group and did not directly measure motivation or cognitive load. The findings are limited to one school, one field-trial class, four sessions, three cultural contexts, and an immediate posttest.

Based on these findings, several recommendations can be made. Mathematics teachers are encouraged to adopt or adapt the LKPD and to design similar worksheets using the cultural resources of their own communities, structuring activities around the four stages of problem solving and including explicit reflection at the end of each task. Schools and teacher forums such as the MGMP can support this work by providing opportunities for collaborative design, expert consultation, and sharing of materials. Researchers are encouraged to prioritize comparative evaluations with control groups, larger and more diverse samples, and longitudinal assessments of learning outcomes.

REFERENCE

Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement, 45*(1), 131–142.

Ambrosio, U. D. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics, 5*(1), 44–48.

Angraini, L. M., & Fitri, Y. C. (2023). The effect of interactive multimedia-based learning on students' mathematical problem solving ability. *International Journal of Contemporary Studies in Education, 2*(2), 85–90.

Arifin, Z. (2017). Mengembangkan instrumen pengukur critical thinking skills siswa pada pembelajaran matematika abad 21. *Jurnal THEOREMS (The Original Research of Mathematics), 1*(2), 92–100.

Christina, E. N. (2021). Analisis kemampuan pemecahan masalah tahapan Polya dalam menyelesaikan persamaan dan pertidaksamaan linear satu variabel. *JPMI (Jurnal Pembelajaran Matematika Inovatif), 4*(2), 405–424.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.).* Lawrence Erlbaum Associates.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297–334.

Damianti, D. A. (2022). Analisis kemampuan pemecahan masalah matematis dan self-efficacy siswa SMP. *INSPIRAMATIKA, 8*(1), 21–30.

Faqiroh, B. Z. (2020). Problem-based learning model for junior high school in Indonesia (2010–2019). *Indonesian Journal of Curriculum and Educational Technology Studies, 8*(5), 42–48.

Fitria, T. N. (2022). Using Canva as media for English Language Teaching (ELT) in developing creativity for informatics students. *ELT Echo, 7*(1), 58–68.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64–74.

Hasan, B. (2019). The analysis of students' critical thinking ability with visualizer-verbalizer cognitive style in mathematics. *International Journal of Trends in Mathematics Education Research, 2*(3), 142–148.

Jannah, F. N. (2023). Penggunaan aplikasi canva dalam media pembelajaran matematika di sekolah dasar. *Jurnal Pendidikan Dasar, 11*(1), 138–146.

Khatimah, H. &. (2019). The effect of problem solving approach to mathematics problem solving ability in fifth grade. *Journal of Physics: Conference Series*, 1320, 042104.

Kholifah, I. N., & Tegeh, I. M. (2024). E-book sebagai bahan ajar berpendekatan kontekstual dalam muatan IPAS sekolah dasar. *Jurnal Penelitian dan Pengembangan Sains dan Humaniora, 8*(2), 151–160.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465–491.

Lubis, D. T. P., & Simbolon, N. (2023). Pengaruh media pembelajaran berbasis Canva terhadap motivasi belajar siswa pada tema 1 subtema 1 siswa kelas V SD Negeri 028227. *Jurnal Handayani, 14*(1), 123–133.

Lubis, U. A. (2024). Pengaruh model pembelajaran matematika realistik (PMR). *Pedagogi: Jurnal Ilmiah Pendidikan, 10*(1), 65–72.

Mariani, S. (2022). The effect of STEM model based on Bima's local cultural on problem solving ability. *International Journal of Instruction, 15*(2), 83–96.

Maulana, M., & Suparman. (2018). Development of students worksheet based on realistic mathematics education in Indonesia. *International Journal of Engineering & Technology, 7*, 45–49.

Mayer, R. E. (2009). *Multimedia learning (2nd ed.).* Cambridge University Press.

Meka, I. Y. (2024). Analisis kebutuhan e-LKPD berbantuan Canva model PBL untuk meningkatkan penguasaan konsep membaca dan kemandirian peserta didik. *El-Hayah, 14*(1).

Misu, L. (2014). Mathematical problem solving of student approach behavior learning theory. *Proceeding of International Seminar*, (pp. 1-8).

Muna, L. N. (2023). PENGEMBANGAN LKPD BERBASIS DISCOVERY LEARNING BERBANTUAN CANVA PADA KELAS V SEKOLAH DASAR. *Prima Magistra: Jurnal Ilmiah Kependidikan, 4*(4), 498-508. doi:https://doi.org/10.37478/jpm.v4i4.3035

Musdalifah, M. L. (2024). Development of Canva-Based Electronic Student Worksheet (E-LKPD) to Improve Student Biology Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*. doi:https://doi.org/10.29303/jppipa.v10i3.6929

Nurazizah, S. Y. (2024). Development of student worksheets with Canva App-assisted problem based learning models to improve skills mathematical literacy of junior high school students. *JCRS (Journal Community Research and Service),, 8*(1), 33–44.

Panggabean, N. H. (2020). Pengembangan bahan ajar berbasis mind mapping pada pembelajaran IPA tema lingkungan sahabat kita. *Jurnal Tunas Bangsa, 7*(2), 204–218.

Pedroso, J. E. (2023). Unlocking the power of Canva: Students' views on using the all-in-one tool for creativity and collaboration. *Journal of Digital Learning and Distance, 2*(2), 443–461.

Polya, G. (1945). *How to solve it: A new aspect of mathematical method.* Princeton University Press.
Pramudiyanti, P. W. (2023). PBL-based student worksheet to improve critical thinking ability in science learning in elementary. *Indonesian Journal of Science and Mathematics Education,, 6 (March)*, 109-124.
Pratama, M. P. (2023). Mengembangkan materi pembelajaran interaktif dengan Canva untuk pendidikan di SMP. *Resonansi: Jurnal Ilmiah Pengabdian Masyarakat, 7*(2), 290–297.
Rahmasari, E. A., & Yogananti, A. F. (2021). Kajian usability aplikasi Canva: Studi kasus pengguna mahasiswa desain. *ANDHARUPA, 7*(01), 165–178.
Rahmi, D. P. (2021). Analisis kemampuan pemecahan masalah matematis berdasarkan Adversity Quotient (AQ) siswa SMA. *Suska Journal of Mathematics Education, 7*(2), 85–94.
Rusli, F., & Azmidar. (2023). Etnomatematika budaya Bugis: Inovasi pembelajaran matematika pada Burasa. *Journal of Math Learning and Innovation, 2*(1).
Setiawi, A. P. (2024). Belajar satuan ukur melalui motif tenun Sumba: Pendekatan matematika kontekstual di SDK Marsudirini Tambolaka. *ADI WIDYA: Jurnal Pendidikan Dasar, 9*(2), 67–75.
Sihombing, N. H. (2024). Penggunaan aplikasi Canva dalam media pembelajaran matematika khususnya di sekolah SD/MI. *Teach Journal Inovasi Karya Ilmiah Guru, 4*(1), 15–26.
Sitorus, C. W. (2025). Pengembangan LKPD berbasis PBL bernuansa etnomatematika di Istana Maimun. *Katalis Pendidikan: Jurnal Ilmu Pendidikan dan Matematika, 2*(1), 220–233.
Suparman, S. Y. (2021). Enhancing mathematical problem-solving skills of Indonesian junior high school students through problem-based learning: A systematic review and meta-analysis. *Al-Jabar: Jurnal Pendidikan Matematika, 12*(1), 1-16.
Surya, E. P. (2020). Batak Toba culture on mathematics learning process at Medan high school. *AIP Conference Proceedings*, *1613*, pp. 1–11.
Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257–285.
Syarifah, N. A. (2025). Development of Canva-Based Interactive Student Worksheets Using the Problem-Based Learning Model. *Journal of Practice Learning and Educational Development, 5*(3), 939-948. doi:https://doi.org/10.58737/jpled.v5i3.5
Tachie, S. A. (2019). Meta-cognitive skills and strategies application: How this helps learners in mathematics problem-solving. *Eurasia Journal of Mathematics, Science and Technology Education, 15*(5), em1702.
Thiagarajan, S. S. (1974). *Instructional development for training teachers of exceptional children: A sourcebook.* Indiana University.
Wijiningsih, N. (2017). Pengembangan bahan ajar tematik berbasis budaya lokal. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 2*(8), 1030–1036.
Wood, D. B. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry, 17*(2), 89–100.
Zhang, T. C. (2019). Authenticity, quality, and loyalty: Local food and sustainable tourism experience. *Sustainability, 11*(12), 3437.

ACKNOWLEDGEMENT

The authors express gratitude to the faculty and students of SMK Negeri 5 Medan for their participation, and to Universitas Pembinaan Masyarakat Indonesia and Universitas Dharmawangsa for institutional support. This research was funded under the Penelitian Dosen Pemula scheme of the Ministry of Higher Education, Science, and Technology of the Republic of Indonesia.

AUTHOR CONTRIBUTION STATEMENT

RFS initiated the research idea, designed the study, and led the manuscript writing. NR contributed to field data collection and documentation of the collaborative learning process. AN conducted data analysis and interpreted the findings related to the dynamics of academic identity. RR contributed to strengthening the theoretical framework and provided critical revisions to the manuscript. All authors contributed to the discussion of the results and approved the final version of the article.

AI DISCLOSURE STATEMENT

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems

***Rizka Fahruza Siregar (Corresponding Author)**
Department of Information Systems, Faculty of Engineering and Computer Science
Universitas Pembinaan Masyarakat Indonesia
Jl. Balai Desa, Marindal Dua, Kecamatan Patumbak, Kabupaten Deli Serdang, Sumatera Utara, 20149, Indonesia
Email: rizkafahruza.siregar@gmail.com

Nova Riani
Department of Information Systems, Faculty of Engineering and Computer Science
Universitas Pembinaan Masyarakat Indonesia
Jl. Balai Desa, Marindal Dua, Kecamatan Patumbak, Kabupaten Deli Serdang, Sumatera Utara, 20149, Indonesia
Email: novarianiharahap@gmail.com

Asrindah Nasution
Department of Business Administrations, Faculty of Social and Political Sciences
Universitas Dharmawangsa
Jl. K.L. Yos Sudarso No. 224, Kelurahan Glugur Kota, Kecamatan Medan Barat, Kota Medan, Provinsi Sumatera Utara, 20115, Indonesia
Email: asrindanasution90@dharmawangsa.ac.id

Rani Rahim
Department of Management, Faculty of Economics and Business
Universitas Dharmawangsa
Jl. K.L. Yos Sudarso No. 224, Kelurahan Glugur Kota, Kecamatan Medan Barat, Kota Medan, Sumatera Utara, 20115, Indonesia
Email: ranirahim@dharmawangsa.ac.id