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Practical Inquiry Tasks for Problem Solving Transfer in Mathematics Classrooms

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ABSTRACT

This study investigated how practical inquiry tasks were associated with problem-solving transfer among Grade 10 learners in secondary Mathematics classrooms in San Pablo, Isabela. Using a quantitative predictive correlational design with an embedded performance-based transfer assessment, data were collected from 180 learners selected through proportionate stratified random sampling. Practical inquiry experiences were assessed across exploration, strategy flexibility, mathematical justification, and practical application, while transfer performance was measured through near-transfer and far-transfer mathematical tasks. Rasch measurement was used to evaluate task difficulty and learner ability, while quantile regression and relative importance analysis determined the contribution of inquiry dimensions across varying levels of transfer performance. Results showed that learners experienced a moderate level of practical inquiry and performed better in near-transfer than in far-transfer tasks, revealing difficulty in applying mathematical knowledge to unfamiliar problem structures. Practical application emerged as the strongest predictor of transfer performance, followed by strategy flexibility and mathematical justification. Exploration showed a weaker contribution, particularly among higher-performing learners. The inquiry dimensions collectively explained a substantial proportion of the variance in transfer performance. The findings indicate that inquiry becomes more effective when learners are required to adapt strategies, justify mathematical decisions, and apply concepts across varied situations. Mathematics instruction should therefore incorporate transfer-oriented tasks that move beyond routine procedures and provide sustained opportunities for flexible reasoning and practical application.

Keywords: *Mathematical justification; practical application; practical inquiry tasks; problem-solving transfer; strategy flexibility; transfer assessment*

INTRODUCTION

Mathematics education is expected to develop more than procedural accuracy. Learners need to recognize mathematical relationships, select appropriate strategies, explain their reasoning, and apply what they know when problems appear in unfamiliar forms. The PISA 2022 mathematics framework places mathematical reasoning and problem solving at the center of mathematical literacy, particularly the ability to formulate situations mathematically, employ mathematical knowledge, and interpret solutions in meaningful situations (OECD, 2023a). This expectation remains difficult for many Filipino learners. In PISA 2022, only 16% of students in the Philippines reached at least Level 2 proficiency in mathematics, indicating continuing difficulty in applying mathematical knowledge even to relatively straightforward situations that require independent interpretation (OECD, 2023b).

One way of addressing this concern is to give learners greater opportunity to investigate mathematical ideas rather than encounter them mainly through completed procedures and routine exercises. Inquiry-based mathematics learning allows students to work with questions, explore possible approaches, discuss relationships, and construct explanations from their own mathematical activity. Evidence from lower secondary mathematics classrooms suggests that inquiry practices are closely connected with problem solving, investigation, and collaboration, while complex problems can create stronger opportunities for meaningful mathematical inquiry (Huang et al., 2021). Practical inquiry tasks may therefore provide a useful classroom structure in which learners examine information, test strategies, justify choices, and connect mathematical ideas with situations that require interpretation.

The value of such tasks also depends on whether learning extends beyond the activity in which it was first developed. Transfer of learning has become an important area of mathematics education research because mathematical competence involves carrying reasoning, representations, and strategies across problems and situations rather than reproducing knowledge only under familiar conditions (Hohensee & Lobato, 2021). This concern is particularly relevant to problem solving, where students must recognize useful mathematical structures even when the wording, information, or demands of a problem change. Work with reality-based mathematical tasks has likewise shown that strategic support can strengthen learners' problem-solving knowledge and, among lower secondary students, improve mathematical modeling competence (Hänze & Leiss, 2022).

These considerations provide the basis for examining Practical Inquiry Tasks for Problem Solving Transfer in Mathematics Classrooms in secondary education in San Pablo, Isabela. The study focuses on how practical inquiry tasks relate to the ability to use mathematical reasoning and problem-solving strategies beyond familiar classroom exercises. By examining this relationship, the study seeks to contribute evidence on how mathematics classrooms can support learners in moving from knowing a procedure toward using mathematical knowledge flexibly when they encounter new problems.

Literature Review

Inquiry-Oriented Mathematical Problem Solving

Inquiry-oriented mathematics places learners in situations where they must examine information, identify mathematical relationships, test possible approaches, and justify how a solution was reached. Such learning differs from exercises that already suggest the procedure to be followed because students are expected to make decisions during the solving process. A meta-analysis conducted by Ramadhani et al. (2021) found that inquiry learning produced a moderate overall effect on students' mathematical problem-solving skills, with a reported effect size of 0.652. The findings suggest that inquiry becomes useful when learners are given sufficient opportunity to explore a problem instead of merely applying a demonstrated rule. For practical inquiry tasks, this is important because their value lies not only in obtaining correct answers but also in developing the reasoning needed to select, examine, and revise mathematical strategies.

Authentic and Open Mathematical Tasks

Practical mathematical inquiry becomes more meaningful when tasks allow learners to work with situations that cannot be solved through a single obvious procedure. Völlinger et al. (2026), in a systematic review of 67 peer-reviewed articles, identified openness as an important feature of real-world mathematical problems. Open tasks may contain incomplete information, permit several solution paths, or require learners to define aspects of the problem before arriving at an answer. Such characteristics encourage students to make assumptions, compare alternatives, and consider whether a mathematical result is reasonable for the situation presented. This type of task is closely aligned with practical inquiry because learners must decide what information matters and how mathematics can be used rather than simply search for a predetermined operation. Exposure to these tasks can therefore provide a stronger setting for developing flexible approaches to unfamiliar mathematical problems.

Transfer of Mathematical Learning

Problem-solving transfer refers to the learner's capacity to carry mathematical knowledge and reasoning into situations that differ from those encountered during instruction. This ability is particularly important because successful performance on practiced exercises does not automatically mean that students can recognize the same mathematical relationships when a problem changes in form or application. Holenstein et al. (2021) examined 4,001 secondary students from Grades 5 to 9 and found evidence of transfer effects associated with mathematical literacy across later areas of academic achievement. Their findings support the view that mathematical learning gains value when students develop reasoning that can function beyond a narrowly practiced task. Practical inquiry tasks may assist this process by requiring learners to interpret conditions, connect prior knowledge with new information, and determine which mathematical ideas remain useful when surface features of a problem change.

Teacher Mediation and Task Design

The effectiveness of inquiry tasks also depends on how teachers select, structure, and facilitate mathematical problems. Tasks must offer enough challenge to encourage independent thought while still allowing learners to develop mathematically sound reasoning. Li et al. (2020) found that teachers who participated in structured workshops on mathematical problem posing improved their problem-posing performance and developed more specific understandings of the benefits and difficulties involved in teaching through such tasks. Their work indicates that inquiry-centered mathematics requires deliberate instructional decisions rather than simply giving students difficult problems. Teachers need to anticipate possible strategies, prepare questions that extend reasoning, and recognize when assistance is necessary without removing the intellectual work from learners. For practical inquiry tasks, teacher mediation may therefore influence whether classroom activities become opportunities for genuine problem solving and whether the reasoning developed during those activities can be applied to succeeding mathematical situations.

METHODS

Research Design

The study employed a quantitative predictive correlational design with an embedded performance-based transfer assessment. Rather than relying solely on learners' perceptions of mathematical problem solving, the design linked their reported exposure to practical inquiry tasks with their demonstrated ability to solve mathematically similar problems presented through unfamiliar situations. The inquiry component examined opportunities for exploration, strategy selection, justification, and application, while the performance component measured whether learners could carry mathematical reasoning from familiar to less familiar problem structures. This design allowed the study to examine problem-solving transfer without manipulating regular classroom instruction.

Research Locale

The study was conducted in the secondary education setting of San Pablo, Isabela. The municipality belongs to the first legislative district of the province and had a recorded population of 26,462 in the Philippine Statistics Authority geographic database. Public secondary education in the locality provided an appropriate setting because Mathematics was taught across the junior high school curriculum and learners encountered both routine and non-routine mathematical tasks. The locale was selected because it provided a defined secondary learner population while allowing the study to examine inquiry and transfer within regular Mathematics instruction.

Participants and Sampling Technique

The participants were 180 Grade 10 learners enrolled in public secondary education in San Pablo, Isabela. Grade 10 learners were selected because they had already completed several years of secondary Mathematics and

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were therefore positioned to apply previously learned concepts to unfamiliar problems. The participant frame was anchored on current DepEd records for the locality, including the 2026 instructional-material allocation data, which recorded 374 learner allocations across the relevant secondary entries in San Pablo. Proportionate stratified random sampling was used so that learners were selected according to their representation in the accessible population while preserving random selection within each stratum. The final sample of 180 was considered sufficient for the planned distribution-sensitive statistical modeling while remaining manageable for individually scored mathematical transfer tasks.

Research Instrument

Data were obtained through two complementary measures. The first was the Practical Inquiry Task Experience Scale, adapted from established inquiry-based mathematics measures and organized around learner exploration, strategy flexibility, mathematical justification, and practical application. Items were rated on a five-point response scale. The adaptation drew particularly from the inquiry-based learning experience measure examined by Huang et al. (2021), whose reported Cronbach alpha was .89 for the Beijing sample and .74 for the Dutch sample. The second measure was an eight-task Mathematical Problem-Solving Transfer Assessment containing four near-transfer and four far-transfer problems. Each response was scored from 0 to 4 according to mathematical interpretation, strategy appropriateness, procedural execution, and justification. Its construction was informed by contemporary performance-based measures of mathematical problem-solving ability, including a 2026 Rasch-validated instrument that reported Cronbach's alpha = .83, person reliability = .76, and item reliability = .99.

The adapted instrument underwent content review by specialists in Mathematics education, educational measurement, and secondary instruction. Each item was examined for relevance, clarity, alignment with the study constructs, and appropriateness for Grade 10 learners. A pilot administration was conducted with 30 Grade 10 learners who were not included in the main sample to determine item clarity, completion time, scoring consistency, and the functioning of the response scales.

Data Gathering

Permission to conduct the study was secured from the appropriate education authorities before participant recruitment. After approval, parental consent and learner assent were obtained because the participants were minors. The Practical Inquiry Task Experience Scale was administered first under standardized classroom conditions, followed by the Mathematical Problem-Solving Transfer Assessment in a separate session to reduce response fatigue. Learners were given approximately 15 minutes for the scale and 45 minutes for the performance tasks. Completed instruments were coded rather than labeled with participant names. Performance responses were independently scored using the prepared analytic rubric, after which the encoded dataset was checked for incomplete responses, scoring inconsistencies, and entry errors before statistical analysis.

Data Analysis

The analysis combined Rasch measurement and quantile regression, providing a more informative treatment than ordinary correlation alone. The Mathematical Problem-Solving Transfer Assessment was first examined through a partial credit Rasch model because responses were scored across ordered performance levels. Item difficulty and learner ability were expressed in logit measures, while item functioning was examined through infit and outfit statistics. Descriptive statistics were then calculated for the dimensions of practical inquiry task experience.

To determine whether practical inquiry predicted different levels of transfer performance, quantile regression was performed at the 25th, 50th, and 75th percentiles of the learners' Rasch-derived transfer scores. This procedure showed whether inquiry-related experiences operated differently among learners with lower, middle, and higher levels of problem-solving transfer, an effect that ordinary least-squares regression could conceal. Bootstrap standard errors based on 5,000 resamples were used to obtain robust confidence intervals.

Relative importance analysis was subsequently applied to determine which inquiry dimensions contributed most strongly to variations in mathematical transfer performance. Statistical decisions were evaluated at the .05 significance level, with effect estimates and 95% confidence intervals reported alongside probability values.

Ethical Considerations

The study observed voluntary participation, informed parental consent, learner assent, confidentiality, and the right to withdraw without academic consequence. Participant identities were replaced with codes, collected information was used solely for research purposes, and individual responses were not disclosed to teachers or used in grading. Electronic and printed records were secured and accessed only for the purposes stated in the approved research protocol.

RESULTS AND DISCUSSION

Table 1. *Level of Practical Inquiry Task Experience of the Learners*

Dimension	Mean	SD	Interpretation
Exploration of Mathematical Situations	3.58	0.58	High
Strategy Flexibility	3.39	0.61	Moderate
Mathematical Justification	3.21	0.66	Moderate
Practical Application	3.16	0.63	Moderate
Overall	3.34	0.54	Moderate

Scale: 4.21–5.00 = Very High; 3.41–4.20 = High; 2.61–3.40 = Moderate; 1.81–2.60 = Low; 1.00–1.80 = Very Low.

Table 1 presents the learners' experience with practical inquiry tasks. The overall mean of 3.34 indicated that inquiry was present in Mathematics lessons but was not consistently experienced across its major features. Exploration of mathematical situations obtained the highest mean of 3.58, suggesting that learners were relatively accustomed to examining problems before completing a solution. In contrast, practical application received the lowest mean of 3.16, followed by mathematical justification at 3.21. The pattern suggests that classroom activities provided more opportunities to explore mathematical situations than to apply ideas to unfamiliar conditions or defend solutions through sustained reasoning. This difference is important because inquiry loses much of its value for transfer when learners explore a task but are not required to explain why a strategy works or determine whether it remains useful when the problem changes.

Table 2. *Learners' Performance in Near and Far Problem-Solving Transfer*

Transfer Measure	Maximum Score	Mean	SD	Mean Percentage	Rasch Ability Logit
Near Transfer	16	10.84	2.31	67.75%	0.42
Far Transfer	16	7.46	2.62	46.63%	-0.37
Overall Transfer	32	18.30	4.15	57.19%	-0.05

Table 2 shows a noticeable difference between near and far problem-solving transfer. Learners obtained 67.75% on near-transfer problems but only 46.63% on far-transfer problems, producing a gap of 21.12 percentage points. The corresponding Rasch measures also moved from 0.42 logits for near transfer to -0.37 logits for far transfer. Learners therefore managed problems that preserved recognizable features of previously encountered mathematical situations more successfully than problems requiring them to detect underlying mathematical structures in unfamiliar forms. The result identifies the central instructional problem addressed by the study. Learners possessed mathematical knowledge, but their ability to detach that knowledge from familiar task structures remained limited. Jacobson et al. (2020) similarly demonstrated that far transfer requires learning

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conditions that help students' abstract relationships across differing problem situations rather than merely master the original task.

Table 3. *Rasch Item Difficulty and Fit Statistics of the Mathematical Problem-Solving Transfer Assessment*

Task	Transfer Type	Difficulty Logit	Infit MnSq	Outfit MnSq
N1	Near	-1.18	0.93	0.90
N2	Near	-0.76	1.04	1.02
N3	Near	-0.41	1.08	1.05
N4	Near	-0.15	0.96	0.98
F1	Far	0.23	1.02	1.06
F2	Far	0.48	1.10	1.13
F3	Far	0.71	0.94	0.97
F4	Far	1.08	1.12	1.16

Person reliability = .78; item reliability = .97; person separation = 1.88; item separation = 5.69.

Table 3 confirms a progressive increase in task difficulty from near-transfer to far-transfer problems. N1 was the easiest item at -1.18 logits, whereas F4 was the most demanding at 1.08 logits. All infit and outfit values remained within the acceptable 0.70 to 1.30 range, indicating that none of the eight tasks behaved erratically relative to the Rasch model. Item reliability of .97 and item separation of 5.69 further showed that the assessment successfully distinguished tasks along different levels of difficulty. More importantly, the ordering of the items supports the substantive result in Table 2. Problems became more difficult as learners were required to move farther from familiar mathematical representations. The difficulty was therefore not simply a matter of performing computations but of recognizing which mathematical concepts and strategies remained applicable when surface features changed.

Table 4. *Quantile Regression of Practical Inquiry Dimensions on Rasch-Derived Problem-Solving Transfer Scores*

Predictor	Quantile	B	95% Bootstrap CI	p
Exploration	25th	0.18	[0.04, 0.32]	.012
Strategy Flexibility	25th	0.31	[0.15, 0.47]	<.001
Mathematical Justification	25th	0.24	[0.10, 0.38]	.001
Practical Application	25th	0.36	[0.19, 0.53]	<.001
Exploration	50th	0.13	[0.01, 0.25]	.032
Strategy Flexibility	50th	0.28	[0.14, 0.42]	<.001
Mathematical Justification	50th	0.20	[0.08, 0.32]	.002
Practical Application	50th	0.32	[0.18, 0.46]	<.001
Exploration	75th	0.08	[-0.04, 0.20]	.184
Strategy Flexibility	75th	0.21	[0.07, 0.35]	.004
Mathematical Justification	75th	0.16	[0.04, 0.28]	.011
Practical Application	75th	0.23	[0.07, 0.39]	.006

Pseudo R^2: 25th percentile = .29; 50th percentile = .34; 75th percentile = .26. Confidence intervals were derived from 5,000 bootstrap resamples.

Table 4 reveals that the relationship between practical inquiry and problem-solving transfer was not uniform across learners. Practical application emerged as the strongest predictor at the 25th percentile ($B = 0.36$, $p < .001$), median ($B = 0.32$, $p < .001$), and 75th percentile ($B = 0.23$, $p = .006$). Strategy flexibility was consistently

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the second strongest predictor. Mathematical justification also remained significant across all three performance levels. Exploration, however, was no longer statistically significant among learners at the 75th percentile (B = 0.08, p = .184). This indicates that simply encountering opportunities to explore problems was insufficient to distinguish stronger transfer performers. What mattered more was whether learners were required to adapt strategies, justify reasoning, and connect mathematical ideas with situations beyond the original exercise. The stronger coefficients at the lower and middle portions of the performance distribution further indicate that inquiry experiences may be particularly consequential for learners who have not yet developed strong transfer ability. This interpretation agrees with evidence that open mathematical problems impose cognitive demands involving identification of relevant quantities, assumptions, and appropriate solution structures, and that instructional support can help learners overcome these barriers (Schukajlow et al., 2023).

Table 5. *Relative Importance of Practical Inquiry Dimensions in Explaining Problem-Solving Transfer*

Dimension	Contribution to R^2	Relative Contribution	Rank
Practical Application	.150	36.59%	1
Strategy Flexibility	.120	29.27%	2
Mathematical Justification	.080	19.51%	3
Exploration	.060	14.63%	4
Total Explained Variance	.410	100.00%	

Table 5 strengthens the quantile regression findings by showing how much each inquiry dimension contributed to the explained variation in transfer performance. Collectively, the four dimensions accounted for 41.0% of the variance in mathematical problem-solving transfer. Practical application made the largest contribution at 36.59% of the explained variance, followed by strategy flexibility at 29.27%. Mathematical justification contributed 19.51%, while exploration accounted for 14.63%. Thus, more than half of the explained variance was associated with learners' opportunities to apply mathematics practically and modify strategies when a familiar approach did not immediately work. The result suggests that inquiry tasks become more productive for transfer when learners must make decisions rather than merely participate in exploratory activity. Teaching for conceptual understanding similarly requires classroom practices that maintain opportunities for substantive mathematical thinking instead of reducing demanding tasks to procedural routines (Yurekli et al., 2020).

Taken together, the results reveal a meaningful but incomplete development of problem-solving transfer. Learners experienced a moderate level of practical inquiry and performed considerably better when new problems remained close to familiar classroom structures. Their performance weakened once mathematical ideas had to be reorganized for substantially different situations. At the same time, the predictive analyses showed that practical application, strategy flexibility, and mathematical justification were consistently associated with stronger transfer performance. The findings therefore point to a specific instructional direction. Mathematics classrooms should not merely increase the number of inquiry activities. Greater attention should be placed on tasks that alter surface features, withhold obvious procedures, permit alternative strategies, require justification, and ask learners to reuse mathematical relationships across different situations. Such conditions may help narrow the observed distance between performing mathematics successfully in a familiar lesson and using mathematics independently when the problem no longer looks familiar.

CONCLUSION

Practical inquiry tasks were meaningfully associated with the development of problem-solving transfer among secondary learners, although their experiences with inquiry remained uneven across dimensions. Learners demonstrated greater success in near-transfer problems than in far-transfer situations, indicating that mathematical knowledge was more readily applied when new tasks retained familiar features. Practical application, strategy flexibility, and mathematical justification emerged as the strongest contributors to transfer performance, while exploration alone provided a weaker contribution among higher-performing learners. These findings suggest that effective inquiry should move beyond allowing students to investigate problems and should require them to adapt strategies, justify decisions, and apply mathematical ideas across unfamiliar situations. It is therefore recommended that secondary Mathematics teachers design inquiry tasks with varied problem structures, multiple solution pathways, practical applications, and explicit opportunities for reasoning and justification. Classroom assessment should also include both near-transfer and far-transfer tasks to determine whether learners can use mathematical knowledge beyond practiced examples. Mathematics coordinators and instructional leaders may further support teachers through professional development focused on designing transfer-oriented inquiry activities, while future studies may examine how sustained exposure to these tasks influences problem-solving transfer across grade levels and mathematical domains.

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