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Guided discovery and inquiry approaches in Mathematics learning: Evidence from student assessment and demographic variations

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Abstract
Aim: This study examines students' assessments of guided discovery and guided inquiry approaches in mathematics learning and investigates their relationship and differences across demographic variables. The study highlights the relevance of learner-centered pedagogical strategies in enhancing teaching effectiveness and student engagement in mathematics education.
Methodology: A quantitative descriptive-correlational research design was employed involving 100 students. Data were collected using a validated questionnaire measuring students' perceptions of guided discovery and guided inquiry. Descriptive and inferential statistical analyses were utilized to examine relationships and differences across demographic variables.
Results: Findings revealed that both guided discovery and guided inquiry approaches were highly implemented in mathematics instruction, with guided inquiry receiving slightly higher ratings. A statistically significant but weak positive relationship was found between the two approaches. No significant differences were observed in students' assessments when grouped according to demographic variables.
Conclusion: The results suggest that integrating guided discovery and guided inquiry strategies supports the development of conceptual understanding, critical thinking, and student engagement in mathematics. These findings emphasize the importance of balanced instructional scaffolding and inquiry-driven learning in improving teaching practices and learning outcomes across diverse student groups.
Keywords: *Guided discovery, guided inquiry, constructivism, student perception, mathematics learning*

INTRODUCTION

Developing mathematical conceptual understanding and higher-order thinking remains a global challenge. Traditional methods—direct instruction, rote memorization, and passive learning—are widely criticized for limiting problem-solving and critical reasoning (Khasawneh et al., 2023). This is reflected in PISA 2022: only 16% of Filipino students reached baseline proficiency, placing the Philippines near the bottom of 81 countries (OECD, 2023). The K–12 Mathematics Curriculum targets higher-order thinking, yet classroom practices still emphasize procedural learning (Gómez-Chacón et al., 2024). In response, educators are adopting student-centered approaches such as guided discovery and inquiry-based learning, grounded in constructivist theory and Bruner's framework. These methods encourage active exploration and independent knowledge construction, with strong evidence linking them to improved understanding, higher-order thinking, and motivation (Weinhandl et al., 2025; Gómez-Chacón et al., 2024).

Students' perceptions of instructional methods are critical but underexplored, directly shaping motivation, engagement, and participation in mathematics (Alcober et al., 2025). However, research mostly focuses on performance, overlooking how students view guided discovery and inquiry-based methods (Weinhandl et al., 2025). Demographic factors like age, sex, and section, which influence learning, are rarely studied together. Alcober et al. (2025) note that these variables affect perceptions differently in the Philippine context. Findings from inquiry classrooms in the UAE and from curriculum reforms in Ghana show that gender and group dynamics also shape perceptions of

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learning (Robinson & Aldridge, 2022; Baidoo-Anu & Ennu Baidoo, 2024). This underscores the need to jointly analyze perceptions and demographic variables, particularly in under-researched Philippine settings.

This study evaluates students' perceptions of guided discovery and inquiry-based mathematics instruction by profiling respondents (age, sex, section), measuring and analyzing perceptions, and identifying significant demographic differences. Findings aligned with the K–12 learner-centered mandate inform curriculum, instruction, and teacher development in Philippine secondary mathematics education.

Review of Related Literature and Studies

Guided Discovery in Mathematics Learning

Guided discovery learning is widely recognized as a constructivist approach. It enhances conceptual understanding, higher-order thinking, and active knowledge construction. This approach positions learners as active agents rather than passive recipients (Alanazi et al., 2024). Empirical evidence consistently affirms its effectiveness. Studies report improved problem-solving performance, greater cognitive flexibility, and overall achievement compared with traditional instruction (Çibukçiu, 2025; Arega et al., 2025) et al., 2025). Observable gains in engagement and learning behaviors also appear (Khasawneh et al., 2023). However, despite these findings, the literature remains largely achievement focused. Students' perceptions and subjective learning experiences are still insufficiently examined.

Inquiry-Based Learning in Mathematics

Inquiry-based learning (IBL) is grounded in constructivism and emphasizes student-driven questioning, investigation, and collaborative meaning-making. Empirical support in mathematics shows IBL improves achievement, engagement, and attitudes, offering benefits over traditional instruction (Khasawneh et al., 2023; Gómez-Chacón et al., 2024). However, most studies focus on performance outcomes, and student perception is often treated as secondary. Where perceptual data are examined, limitations exist. For example, Gómez-Chacón et al. (2024) focus on Europe, so it remains unclear how Philippine learners perceive IBL. This highlights the need for localized, perception-centered research.

Student Assessment and Perceptions of Instructional Approaches

Student perceptions of instructional methods strongly affect motivation, engagement, and sustained learning. Evidence shows that learners who see instruction as meaningful and participatory display deeper learning behaviors (Alcober et al., 2025). In the Philippine context, Alcober et al. (2025) found generally positive perceptions of student-centered mathematics instruction among sixth-grade students. However, these perceptions did not consistently lead to higher achievement. This highlights the complex, non-linear relationship between perception and performance and supports treating perception as an independent construct. Notably, no significant gender differences were observed, aligning with Khasawneh et al. (2023). Despite these insights, existing studies have not examined students' perceptions of guided discovery and inquiry-based learning together or analyzed their relationship, thereby revealing a methodological gap that the present study addresses (Gómez-Chacón et al., 2024; Alcober et al., 2025).

Demographic Variables and Variations in Learning

Demographic variables age, sex, and class section moderate students' perceptions of instructional approaches. These factors shape readiness for abstract reasoning, engagement, and learning experiences (Nwoye et al., 2026). Evidence shows different psychological and academic outcomes across groups. Gender appears to have context-dependent effects (Alcober et al., 2025; Gómez-Chacón et al., 2024). Section-level differences in teacher interaction and peer dynamics also significantly influence perception (Wilkins et al., 2021). Despite these findings, research has not yet examined how these variables simultaneously affect students' perceptions of guided discovery and inquiry-based learning, particularly in the Philippine secondary context.

Synthesis and Research Gap

The literature shows that guided discovery and inquiry-based learning effectively enhance understanding, problem-solving, and higher-order thinking beyond traditional instruction. However, key gaps remain: student perceptions are underexamined, the influence of demographics is unclear, and few studies compare both approaches, particularly in the Philippine context. This study addresses these gaps by analyzing students' perceptions of both approaches, their relationship, and differences across age, sex, and section.

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Theoretical Framework

The study is anchored on Constructivist Learning Theory and Jerome Bruner's Discovery Learning Theory, both foundational to the Philippine K–12 Mathematics Curriculum (Department of Education, 2024). Constructivism posits that mathematical knowledge is actively constructed through scaffolded exploration a process Vygotsky's ZPD operationalizes, and one empirically confirmed to outperform traditional instruction (Çibukçiu, 2025; Arega, 2025). Bruner extends this by asserting that understanding deepens through intrinsically motivated, guided exploration (Weinhandl et al., 2025). Within this dual framework, students' perceptions of guided discovery and guided inquiry, respectively, indicate whether constructivist knowledge-building and Brunerian sense-making were meaningfully engaged, with a positive association between both perceptions theoretically expected from their shared epistemological base. Demographic variables age, sex, and section are treated as contextual moderators reflecting constructivist recognition that developmental readiness and social situatedness shape ZPD engagement (Nwoye et al., 2026).

Statement of the Problem

Despite the increasing adoption of learner-centered approaches in mathematics education, there remains limited empirical evidence on how students evaluate guided discovery and guided inquiry as instructional strategies. Existing studies have largely focused on academic performance outcomes, with less attention given to students' perceptions, which are critical in shaping motivation, engagement, and meaningful learning. Furthermore, the influence of demographic variables such as age, sex, and section on students' assessments of these approaches remains underexplored.

This gap limits educators' understanding of how different instructional strategies are experienced by learners and how these experiences may vary across diverse student groups. Addressing this issue is essential for improving instructional design and promoting more responsive and effective teaching practices in mathematics.

Thus, this study investigates the relationship between students' assessments of guided discovery and guided inquiry in learning mathematical concepts and examines whether significant differences exist when grouped according to selected demographic variables.

Research Objectives

General Objective:

To assess the role of guided discovery and guided inquiry approaches in learning mathematical concepts.

Specific Objectives:

1. To determine the profile of the student-respondents in terms of:
   a. Age;
   b. Sex; and
   c. Section.
2. To assess the level of students' evaluation of guided discovery and guided inquiry in learning mathematical concepts.
3. To examine the significant relationship between students' assessments of guided discovery and guided inquiry in learning mathematical concepts.
4. To determine the significant differences in students' assessments of guided discovery and guided inquiry when grouped according to demographic variables.

Research Questions

1. What is the profile of the student-respondents in terms of:
   a. Age;
   b. Sex; and
   c. Section?
2. What is the level of students' assessment of guided discovery and guided inquiry in learning mathematical concepts?
3. Is there a significant relationship between students' assessment of guided discovery and guided inquiry in learning mathematical concepts?
4. Is there a significant difference in students' assessment of guided discovery in learning mathematical concepts when grouped according to age, sex, and section?

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5. Is there a significant difference in students' assessment of guided inquiry in learning mathematical concepts when grouped according to age, sex, and section?

Hypotheses

H_{01}: There is no significant relationship between students' assessment of guided discovery and guided inquiry in learning mathematical concepts.

H_{11}: There is a significant relationship between students' assessment of guided discovery and guided inquiry in learning mathematical concepts.

H_{02}: There is no significant difference in students' assessment of guided discovery in learning mathematical concepts when grouped according to age, sex, and section.

H_{12}: There is a significant difference in students' assessment of guided discovery in learning mathematical concepts when grouped according to age, sex, and section.

H_{03}: There is no significant difference in students' assessment of guided inquiry in learning mathematical concepts when grouped according to age, sex, and section.

H_{13}: There is a significant difference in students' assessment of guided inquiry in learning mathematical concepts when grouped according to age, sex, and section.

METHODOLOGY

Research Design

This study employed a quantitative, descriptive-correlational, and comparative research design. The descriptive component characterized students' assessments of guided discovery and guided inquiry in mathematics learning. The correlational component examined the relationship between these two assessments, while the comparative component determined whether significant differences existed across demographic groups. This integrated design is appropriate for studies that seek to describe variables, establish associations between them, and identify group-based variations without manipulating any conditions (Creswell & Creswell, 2022).

Population and Sampling

The respondents consisted of secondary school students enrolled in mathematics courses from selected public schools within the Schools Division of Cavite, Philippines, representing the study's accessible population. A total of 100 students who met the inclusion criterion of active enrollment in mathematics during the data collection period were included in the study. Purposive sampling was used to select participants deemed relevant to the study's objectives. This approach ensured that the respondents possessed the necessary characteristics to provide meaningful data on guided discovery and guided inquiry within the context of mathematics instruction.

Research Instrument

Data were gathered using a researcher-developed survey questionnaire divided into three parts: Part I collected respondents' demographic profiles (age, sex, and section); Part II assessed perceptions of guided discovery through 20 items covering teacher facilitation, structured exploration, learner engagement, and conceptual understanding; and Part III assessed perceptions of guided inquiry through 20 items addressing independent investigation, critical thinking, problem-solving, and application of concepts. Both parts used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), with composite mean scores interpreted across five ranges from 1.00–1.80 (Strongly Disagree) to 4.21–5.00 (Strongly Agree). Content validity was established through expert panel review, and reliability was confirmed via pilot testing using Cronbach's alpha ($\alpha = 0.86$), which exceeded the acceptable threshold of 0.70 (Park, 2024).

Data Collection Procedure

Before data collection, institutional approval was secured from the school principal and relevant mathematics teachers. Respondents were informed of the study's purpose, the voluntary nature of their participation, and their right to withdraw without consequence. Written consent was obtained before questionnaire administration. Questionnaires were distributed and retrieved on a scheduled date under the researcher's supervision. Completed responses were reviewed for completeness before encoding to ensure data integrity.

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Treatment of Data

Data were analyzed in accordance with each research objective using appropriate descriptive and inferential statistical techniques. Frequency counts and percentages were employed to describe the demographic profile of the respondents and to summarize their distribution across relevant categories. The mean was used to determine students' levels of assessment for guided discovery and guided inquiry, with scores interpreted on a five-point Likert scale. To examine the relationship between the two assessment variables, Kendall's Tau (τ) was utilized. Differences in assessments across groups were analyzed using the Kruskal–Wallis H test and the Mann–Whitney U Test. All statistical analyses were conducted at the 0.05 level of significance.

Ethical Considerations

The study adhered to established ethical standards, with institutional approval obtained from school authorities before data collection. Respondents voluntarily consented to participate, were informed of the study's objectives, and were assured that withdrawal carried no penalty. All data were kept anonymous and confidential, and reported with full fidelity to the actual results.

RESULTS and DISCUSSION

This section presents the results of the study and provides a comprehensive discussion based on research questions. The findings are interpreted considering established learning theories and related empirical literature to clarify the observed results.

Table 1
Profile of the student-respondents in terms of age, sex and section

PROFILE	FREQUENCY	PERCENTAGE
Age		
17	10	10
18	72	72
19	11	11
20>	7	7
Total	100	100
Sex		
Male	54	54
Female	46	46
Total	100	100
Section		
A	40	40
B	40	40
C	20	20
Total	100	100

Table 1 presents the demographics of the participants, including age, sex, and section. Most participants (72%) were 18 years old, 19 years old (11%), 17 years old (10%), and 20 years old or above (7%). Therefore, we can consider the sample predominantly late adolescent. This age group has the capacity for higher-order thinking, which is essential for guided discovery and inquiry-based learning. The participants were also balanced by sex (54% male, 46% female), which supports the validity of the comparisons. Participants were evenly spread across sections: A (40%), B (40%), and C (20%), indicating some variation in classroom settings, where the implementation of different teaching practices and peer influence may affect learning.

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The age homogeneity strengthened the case for guided discovery and inquiry strategies for this group of cognitively similar learners, while the sex balance improved the case for constructive comparative analyses. The section variation justified the need to consider classroom context when interpreting students' assessments, as different teaching practices may have influenced the learning experiences.

Table 2
Assessment of the student-respondents on guided discovery and inquiry in learning mathematical concepts

STATEMENT	MEAN	SD	INTERPRETATION
Our Mathematics teacher…			
Guided Discovery			
2.1 encourages us to participate in the learning process by manipulating objects, solving problems, and making observations to identify patterns and relationships.	3.32	0.47	Very True of Our Teacher
2.2 guides us through the discovery process by asking probing questions, providing hints when needed, and fostering discussion to help students reach our own conclusions.	3.32	0.47	Very True of Our Teacher
2.3 emphasizes not memorizing formulas, but to understand the underlying logic and reasoning behind mathematical concepts.	3.40	0.49	Very True of Our Teacher
2.4 provides support structures like visual aids, prompts, or relevant examples to help students navigate the discovery process at our own pace.	3.25	0.44	Very True of Our Teacher
2.5 lets us take responsibility for exploring the content needed to understand a concept, often using study guides and examples to facilitate their self-directed learning.	3.25	0.44	Very True of Our Teacher
2.6 presents with a series of multiplication problems and asked to look for patterns in the products, leading them to discover the commutative property of multiplication.	3.40	0.49	Very True of Our Teacher
2.7 lets us retain information when we actively discover it ourselves, leading to a deeper conceptual understanding.	3.55	0.50	Very True of Our Teacher
2.8 encourages us to develop critical thinking and problem-solving abilities through exploring and questioning	3.71	0.46	Very True of Our Teacher
2.9 encourages active participation in the learning process that leads to greater student engagement and motivation.	3.77	0.42	Very True of Our Teacher
Sub Mean	**3.44**	**0.46**	**Very True of Our Teacher**
Guided Inquiry			
2.10 poses questions that encourage multiple approaches and deeper thinking, prompting students to explore different possibilities and explain their reasoning.	3.41	0.49	Very True of Our Teacher
2.11 makes us engage in hands-on activities, manipulatives, and real-world scenarios to discover patterns and relationships within the mathematical concept.	3.41	0.49	Very True of Our Teacher

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2.12 encourages us to share our strategies, ideas, and justifications with peers, promoting critical analysis and refining our understanding through discussion.	3.52	0.50	Very True of Our Teacher
2.13 provides timely support and guidance by asking clarifying questions, offering hints, and prompting students to connect new concepts to prior knowledge.	3.52	0.50	Very True of Our Teacher
2.14 lets us explain our thinking, provide evidence to support our claims, and defend our reasoning when presenting solutions.	3.60	0.49	Very True of Our Teacher
2.15 develops in us a richer comprehension of mathematical concepts by actively engaging with us and at the same time allowing constructing our own knowledge.	3.86	0.35	Very True of Our Teacher
2.16 explores different strategies and approaches, which make us more confident in applying mathematical concepts to solve complex problems.	3.75	0.44	Very True of Our Teacher
2.17 fosters critical thinking abilities in us through the process of questioning, analyzing, and justifying reasoning.	3.66	0.48	Very True of Our Teacher
2.18 encourages students to ask open-ended questions, and teachers use questions to provoke deeper thinking and guide students to explore concepts more thoroughly.	3.66	0.48	Very True of Our Teacher
Sub Mean	**3.60**	**0.47**	**Very True of Our Teacher**
OVERALL MEAN	**3.52**	**0.47**	**Very True of Our Teacher**

Scale:
4.00-3.25 Very True of our teachers
3.24-2.50 True of our teachers
2.49-1.75 Moderately True of our teachers
1.74-1.00 Least true of our teachers

The findings indicate that both guided discovery (M = 3.44) and guided inquiry (M = 3.60) were perceived as highly implemented instructional approaches. The slightly higher rating of guided inquiry suggests that students respond more positively to learning environments that promote autonomy, questioning, and independent reasoning. This supports the view that inquiry-based approaches enhance deeper engagement and conceptual understanding in mathematics (Koswara & Rusnilawati, 2025; Şengül, 2025).

From a pedagogical perspective, these results highlight the importance of balancing structured guidance and independent exploration. Teachers may strengthen instructional practices by integrating guided discovery as a foundational scaffold while gradually transitioning students toward inquiry-based learning. Curriculum developers may also consider embedding inquiry-oriented tasks and problem-based activities within mathematics programs to foster higher-order thinking skills.

Table 3
Significant relationship between guided discovery and inquiry in learning mathematical concepts

ASSESSMENT	N	SUM OF RANKS	AVG. RANK	CHI-SQUARE	KENDALL TEST	P-VALUE	REMARKS
Guided Discovery	100	134.50	1.35	10.798	0.108	0.001	

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Guided Inquiry	100	165.50	1.66		Very weak positive correlation

Level of Sig. <.05 *df=1*

The weak but significant relationship between guided discovery and guided inquiry indicates that while the two approaches are related, they function as distinct instructional strategies. This supports the constructivist perspective that different learning processes contribute uniquely to knowledge construction (Priandani et al., 2025; Weinhandl et al., 2025).

For instructional practice, this implies that teachers may design lessons that intentionally combine both approaches—using guided discovery to introduce concepts and guided inquiry to deepen understanding. Teacher education programs may also incorporate training on how to effectively integrate these complementary strategies in classroom instruction.

Table 4
Significant difference in the assessment of the student-respondents when grouped accordingly

ASSESSMENT	Test	N	DF	Test Statistic	P-VALUE	REMARKS
Guided Discovery						
Age	Kruskal –Wallis	100	3	0.281	0.964	Accept Ho
Sex	Mann-Whitney	100	---	1187.00	0.436	Accept Ho
Section	Kruskal –Wallis	100	2	0.641	0.726	Accept Ho
Guided Inquiry						
Age	Kruskal –Wallis	100	3	0.703	0.872	Accept Ho
Sex	Mann-Whitney	100	---	1215.50	0.589	Accept Ho
Section	Kruskal –Wallis	100	2	0.654	0.721	Accept Ho

Level of Sig. <.05

The results of the study revealed that there were no statistically significant differences in Guided Discovery and Guided Inquiry assessments when respondents were grouped according to age, sex, and section. Using the Kruskal-Wallis Test for age and section, and the Mann–Whitney U Test for sex, all computed p-values were greater than the 0.05 level of significance. Thus, the null hypothesis was accepted across all variables.

The absence of significant differences across demographic variables suggests that guided discovery and guided inquiry are effective across diverse student groups. This supports the notion that well-designed instructional strategies have a greater impact than demographic characteristics. As emphasized by Amri et al. (2025) and Glock et al. (2024), learner-centered approaches that promote active engagement and inquiry-based learning tend to produce consistent outcomes regardless of students' backgrounds.

This finding indicates that guided discovery and guided inquiry are robust instructional approaches that can be applied effectively across heterogeneous classrooms. These strategies emphasize active participation, exploration, and critical thinking, enabling students to construct knowledge independently of demographic constraints. Consequently, the effectiveness of instruction appears to be more closely tied to pedagogical design than to differences in age, sex, or section. The findings also have important implications for educational equity and inclusivity. Since no group demonstrated a significant advantage over others, educators and school leaders may confidently implement these learner-centered strategies as inclusive practices that benefit all students. Curriculum planners may likewise

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prioritize instructional designs that foster inquiry, collaboration, and higher-order thinking skills, ensuring equal learning opportunities across diverse learner populations.

Conclusions

Based on analysis and interpretation of data, the following conclusions were drawn:

1. The findings indicate that guided discovery and guided inquiry are both highly implemented instructional approaches in mathematics, demonstrating their effectiveness in promoting student engagement and conceptual understanding.
2. Guided inquiry emerged as slightly more influential in fostering critical thinking and deeper learning, highlighting the value of inquiry-driven pedagogies in mathematics education.
3. The weak but significant relationship between the two approaches confirms that they function as complementary strategies, supporting the integration of structured guidance and independent exploration in instructional design.
4. The absence of significant differences across demographic variables suggests that these approaches are inclusive and applicable across diverse learning contexts.
5. The study contributes to educational practice by emphasizing the importance of balanced constructivist strategies in improving teaching effectiveness, curriculum design, and learner engagement in mathematics.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Mathematics teachers may integrate guided discoveries and guided inquiry approaches progressively, beginning with structured exploration and gradually transitioning to independent inquiry-based tasks.
2. Teachers may enhance scaffolding strategies in guided discovery by providing clearer prompts, structured support, and targeted feedback to assist students in concept formation.
3. Schools and instructional leaders may support professional development programs that train teachers in implementing inquiry-based and constructivist teaching strategies.
4. Curriculum developers may incorporate inquiry-driven and problem-based learning activities into mathematics curricula to promote critical thinking and conceptual understanding.
5. Educational policymakers may encourage the adoption of learner-centered instructional frameworks that support inclusive and equitable learning environments.
6. Future researchers may explore additional variables such as teacher competence, classroom environment, and learning outcomes to further strengthen the evidence on constructivist approaches in mathematics education.

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