# Research Skills of Ste Students through Cognitive Apprenticeship Strategy

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## ABSTRACT

This study examined the effectiveness of the Cognitive Apprenticeship Strategy (CAS) in improving the research skills of Grade 8 Science, Technology, and Engineering (STE) students at Impasugong National High School. Specifically, it assessed students' competencies in objective formulation, literature review writing, and methodology development before and after the intervention, and explored their learning experiences to complement the quantitative findings. A sequential explanatory mixed-methods design was employed, integrating a one-group pretest–posttest approach with semi-structured interviews. The quantitative phase utilized a researcher-made scenario-based assessment evaluated through a validated rubric with high inter-rater reliability, while qualitative data were analyzed using thematic analysis. Results revealed that prior to CAS implementation, students demonstrated generally low to developing research skills, with difficulties in formulating clear objectives, selecting and synthesizing literature, and organizing research methodologies. After the intervention, students showed significant improvement across all domains, reaching proficient to highly proficient levels, with methodology development obtaining the highest post-test performance. Paired-sample t-test results confirmed statistically significant gains in all areas ($p = .000$), while Cohen's d values indicated very large effect sizes, demonstrating strong practical significance. Qualitative findings supported these results, highlighting that modeling, scaffolding, coaching, and guided practice helped students better understand research processes. However, some learners still expressed limited confidence in independent research writing. Overall, CAS was found to be an effective instructional strategy in enhancing students' research competencies. The study concludes that structured and scaffolded instruction significantly improves research skill development among STE learners. It recommends the integration of CAS into science instruction to strengthen research literacy and higher-order thinking skills in secondary education.

**Keywords:** Cognitive Apprenticeship Strategy, research skills, STE students, sequential explanatory mixed-methods

## INTRODUCTION

Science education plays a vital role in developing learners' scientific literacy, enabling them to think critically, solve problems, and make evidence-based decisions in real-world contexts (National Research Council [NRC], 2012). In the Philippine basic education system, the Department of Education (DepEd, 2016) emphasizes inquiry-based and research-oriented learning through the Science, Technology, and Engineering (STE) program. This program requires students to develop competencies in problem formulation, literature review writing, data interpretation, and methodology development as essential components of scientific inquiry (DepEd, 2019).

Despite these curricular expectations, studies show that many learners still experience difficulties in performing research tasks. STE students often struggle in constructing clear research objectives, synthesizing literature, and designing appropriate methodologies (Cuayzon, 2024; Ca-alim, 2021). These challenges suggest gaps in instructional practices that fail to adequately scaffold the cognitive processes involved in research development. Freitas et al. (2023) and Lagulos (2025) further emphasize that learners require structured guidance and explicit instruction to effectively develop research competencies.

The Cognitive Apprenticeship Strategy (CAS), introduced by Collins, Brown, and Newman (1989), provides a structured instructional approach that makes expert thinking visible through modeling, coaching, scaffolding, reflection, and gradual transfer of responsibility. Recent studies support its effectiveness in improving higher-order thinking and research-related skills. For instance, Ahmed et al. (2025) found that CAS significantly enhances students' higher-order thinking skills, while De La Paz et al. (2022) reported improvements in disciplinary writing and scientific argumentation. Similarly, Hilary et al. (2022) demonstrated that cognitive apprenticeship improves literature review and research competencies in science-related fields.

Given these considerations, this study investigates the effectiveness of CAS in improving the research skills of Grade 8 STE students at Impasugong National High School. It specifically examines students' performance in objective formulation, literature review writing, and methodology development before and after the intervention, and explores their learning experiences to enrich the quantitative findings.

The study aims to contribute to the growing body of literature on instructional strategies in science education and provide empirical evidence on the effectiveness of Cognitive Apprenticeship in strengthening students' research competencies and scientific literacy.

# METHODOLOGY

## Research Design

The study employed a sequential explanatory mixed-methods design, integrating quantitative and qualitative approaches to examine the effect of the Cognitive Apprenticeship Strategy (CAS) on the research skills of Grade 8 Science, Technology, and Engineering (STE) students.

The quantitative phase utilized a one-group pretest–posttest design, appropriate for an intact class where random assignment was not feasible. Students' research skills in objective formulation, literature review writing, and methodology development were assessed before and after the implementation of CAS using a scenario-based assessment.

The qualitative phase involved semi-structured interviews conducted before and after the intervention to explore students' learning experiences. The qualitative data were used to complement and explain the quantitative findings, providing a more comprehensive understanding of how CAS supports research skill development.

## Locale of the Study

The study was conducted at Impasugong National High School, a public secondary school under the Division of Bukidnon, located at Purok 9 Poblacion, Impasugong, Bukidnon, Philippines. The school serves both junior and senior high school students and is equipped with facilities and instructional programs that support Science, Technology, and Engineering (STE) education. This setting provided an appropriate context for examining the implementation of the Cognitive Apprenticeship Strategy in enhancing students' research skills.

## Participants of the Study

The participants of the study were a single intact Grade 8 Science, Technology, and Engineering (STE) class from Impasugong National High School, Bukidnon. The same group of students participated in both the pretest and posttest assessments to determine changes in their research skills following the implementation of the Cognitive Apprenticeship Strategy (CAS). The selection of the intact class was based on practical considerations, including class size, prior exposure to research tasks, and the availability of classroom resources during the intervention period.

For the qualitative phase, twelve (12) students were purposively selected from the same intact class. Selection was based on variation in pretest performance (low, average, and high scorers), willingness to participate in the interviews, and availability during the interview schedule. This ensured representation of diverse learning

experiences and provided in-depth qualitative insights into students' perceptions of the Cognitive Apprenticeship Strategy (CAS).

**Instrumentation**

The study utilized both quantitative and qualitative instruments to gather data. The primary quantitative instrument was a researcher-made Scenario-Based Assessment (SBA) anchored on established SBA principles (Zhang et al., 2019; Linh, 2024). The assessment presented students with authentic research situations requiring them to formulate objectives, review relevant literature, and develop appropriate methodologies. To ensure content validity, the SBA and the Research Skills Assessment Rubric (RSAR) were reviewed by experts in research and science education. The experts evaluated the clarity, relevance, and alignment of the assessment tasks and rubric criteria with the intended learning outcomes. Revisions were made based on their recommendations prior to the final administration of the instruments.

The RSAR was used to evaluate student outputs across three domains: objective formulation, literature review writing, and methodology development, each with clearly defined performance criteria. Three experts in research and science education independently rated the students' outputs to ensure reliability and minimize scoring bias. Inter-rater reliability was determined using the Intraclass Correlation Coefficient (ICC). A two-way random effects model with absolute agreement and average measures (ICC(2,k)) was employed to assess consistency among the three raters. Results showed statistically significant reliability ($p = .000$) across all assessment domains, indicating strong agreement among raters. For the Objective Before (OB), the ICC was 0.899, while the Literature Review Before (LRB) obtained 0.772, and the Methods Before (MB) recorded 0.915. In the post-assessment, the Objective After (OA) showed 0.934, followed by the Literature Review After (LRA) with 0.851, and the Methods After (MA) with 0.815. Overall, the results indicate that the reliability coefficients fall within the good to excellent range, confirming consistent scoring and the dependability of the assessment rubric across all domains.

Students' scores were converted into percentage values using the formula: Percentage Score = (Score Obtained / Maximum Score) × 100, and were interpreted using the following scale: 0–25 (Needs Improvement), 26–50 (Developing), 51–75 (Proficient), and 76–100 (Highly Proficient).

For the qualitative data, a semi-structured interview guide was used as the primary data collection instrument. The interview protocol consisted of open-ended questions designed to elicit students' experiences in research tasks, including their prior experiences, difficulties encountered before the implementation of the Cognitive Apprenticeship Strategy (CAS), perceived changes after its implementation, specific components of CAS that facilitated learning, and remaining challenges in developing research skills.

Qualitative data were analyzed using thematic analysis following Braun and Clarke's (2006) six-phase framework. These phases involved: (1) familiarization with the data through repeated reading of interview transcripts, (2) generating initial codes from meaningful segments of data, (3) searching for patterns by grouping related codes, (4) developing preliminary themes, (5) reviewing and refining themes for coherence and consistency, and (6) defining and naming the final themes.

**Implementation of the Cognitive Apprenticeship Strategy**

The Cognitive Apprenticeship Strategy (CAS) was implemented through a series of structured phases. In the modeling phase, the teacher demonstrated key research processes such as objective formulation, literature review writing, and methodology design to provide students with clear examples of expert performance. This was followed by the coaching and scaffolding phase, where students practiced research tasks with guided feedback and support from the teacher, which was gradually reduced as their competence improved. In the guided practice and reflection phase, students applied the learned skills to accomplish research tasks while reflecting on their outputs, challenges, and learning processes through discussion and feedback. Finally, in the independent practice phase, students independently completed research-related activities by integrating all the competencies they had developed throughout the instructional process.

### Data Analysis

Descriptive statistics, specifically mean and standard deviation, were used to summarize students' research skill performance before and after the implementation of the Cognitive Apprenticeship Strategy (CAS) in terms of objective formulation, literature review writing, and methodology development.

A paired-sample t-test was used to determine whether there was a significant difference between the pretest and posttest scores, with a 0.05 level of significance as the basis for decision-making.

In addition, qualitative data were analyzed thematically to identify students' learning experiences, which were used to support and provide deeper explanation of the quantitative result**s.**

### Ethical Considerations

Ethical protocols were strictly observed throughout the study. Consent forms were secured from parents or guardians. In compliance with Republic Act No. 10173 (Data Privacy Act of 2012), all participant information was treated with strict confidentiality and used solely for research purposes. Participants were informed of the study's objectives, procedures, and their right to withdraw or refuse participation at any stage without penalty. Participant anonymity was maintained, and they were informed that they could skip questions or discontinue participation if they felt uncomfortable.

## RESULTS AND DISCUSSION

### Research Skills of STE Students Before Exposure to Cognitive Apprenticeship Strategy (CAS)

Prior to the implementation of the Cognitive Apprenticeship Strategy (CAS), Grade 8 STE students demonstrated generally low to developing research competencies in objective formulation, literature review writing, and methodology development.

Table 1: Joint Display of Grade 8 STE Students' Research Skills Before CAS

| **Research Skills** | **QUANTITATIVE RESULTS** | | | **QUALITATIVE RESULTS** | |
|---|---|---|---|---|---|
| | N (%) Summary | MPS | QI | Themes | Confirmatory Statements |
| Objective Formulation | 71.05% D 28.95% P | 45.96 | D | Difficulty in writing clear and aligned research objectives | "Making objectives is hard"<br>"Hard to align it to the topic"<br>"Difficult to make it specific and measurable" |
| Literature Review Writing | 81.58% D 18.42% P | 42.98 | D | Difficulty in selecting sources and academic writing skills | "Too much information, hard to choose"<br>"APA citation is confusing."<br>"It's hard to paraphrase and organize ideas" |
| Methodology Development | 57.89% D 42.11% P | 50.53 | D | Difficulty in organizing and aligning research procedures | "It is hard to arrange the steps in order." |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | "It is difficult to match the procedures with the objectives."<br><br>"I am not sure if the steps are relevant." |

Legend:

| Percentage Score Range | Qualitative Interpretation (QI) |
|---|---|
| 0-25 | Needs Improvement (NI) |
| 26-50 | Developing (D) |
| 51-75 | Proficient (P) |
| 76-100 | Highly Proficient (HP) |

Quantitative results show that students were predominantly at the Developing level across all domains, with mean percentage scores (MPS) of 45.96 for objective formulation, 42.98 for literature review writing, and 50.53 for methodology development. Among the three domains, literature review writing recorded the lowest performance, while methodology development obtained the highest MPS but still remained within the developing range.

Although some students reached the proficient level in specific indicators, overall results suggest insufficient mastery of foundational research skills. This aligns with findings that learners often struggle with research writing, synthesis of literature, and methodological planning due to limited scaffolding and exposure to authentic research tasks (Cuayzon, 2024; Lagulos, 2025).

Qualitative findings further support these results, revealing difficulties in formulating clear objectives, organizing literature, and sequencing research procedures. Similar challenges among novice researchers have been documented in prior studies emphasizing the need for structured instructional support (Matsuo & Tsukube, 2020; Freitas et al., 2023).

**Research Skills of STE Students After Exposure to the Cognitive Apprenticeship Strategy (CAS)**

After the implementation of the Cognitive Apprenticeship Strategy (CAS), Grade 8 STE students demonstrated marked improvement in their research competencies across objective formulation, literature review writing, and methodology development. Quantitative results show that most students reached the proficient to highly proficient levels in all domains, with mean percentage scores (MPS) of 70.96 for objective formulation, 64.74 for literature review writing, and 74.30 for methodology development. Methodology development recorded the highest performance, with all students classified as either proficient or highly proficient.

Table 2: Joint Display of Grade 8 STE Students' Research Skills After CAS

| **Research Skills** | **QUANTITATIVE RESULTS** | | | **QUALITATIVE RESULTS** | |
|---|---|---|---|---|---|
| | N (%) Summary | MPS | QI | Themes | Confirmatory Statements |
| Objective Formulation | 13.16% D<br>44.74% P | 70.96 | P | Improved research skills through guided instruction and | "Yes, because the teacher showed us sample work." |

| | | | | | |
|---|---|---|---|---|---|
| | 42.10% HP | | | practice, but with limited confidence | "Through demonstrations, I learned how to write SMART objectives."<br><br>"We practiced during workshops with teacher guidance." |
| Literature Review Writing | 15.79% D<br><br>57.89% P<br><br>26.32% HP | 64.74 | P | Improved research skills through guided instruction and practice, but with limited confidence | "I learned how to write RRL with citations."<br><br>"We practiced while doing the task."<br><br>"It is a bit easier, but I still need to learn more." |
| Methodology Development | 60.53% P<br><br>39.47% HP | 74.30 | P | Improved research skills through guided instruction and practice, but with limited confidence | "Workshops helped me understand the methods."<br><br>"Teacher guided us while doing the steps."<br><br>"I learned how to align procedures to objectives." |

Legend:

| Percentage Score Range | Qualitative Interpretation (QI) |
|---|---|
| 0-25 | Needs Improvement (NI) |
| 26-50 | Developing (D) |
| 51-75 | Proficient (P) |
| 76-100 | Highly Proficient (HP) |

These improvements are consistent with studies showing that structured and scaffolded instruction enhances students' research writing skills and higher-order thinking abilities (De La Paz et al., 2022; Hilary et al., 2022). Similar findings also emphasize that guided instructional approaches significantly improve STEM learners' research competencies (Cuayzon, 2024; Tabafa & Sariana, 2025).

Qualitative findings supported these results, revealing that students attributed their improvement to guided instruction, teacher demonstrations, and hands-on workshops. However, some students still expressed limited confidence, particularly in writing and organizing research outputs independently. Despite this, learners reported better understanding of research processes, including writing SMART objectives, using citations in literature reviews, and aligning methodologies with research objectives. This reflects the effectiveness of Cognitive Apprenticeship principles such as modeling, scaffolding, and coaching in supporting skill development (Collins et al., 1989; National Research Council, 2012).

The findings indicate that CAS significantly enhanced students' research skills, particularly through structured scaffolding, modeling, and guided practice. This improvement aligns with research emphasizing that scaffolded instruction strengthens research literacy, writing competence, and procedural understanding among secondary learners (Freitas et al., 2023; Lagulos, 2025; Matsuo & Tsukube, 2020).

**Paired Samples t-test Analysis of Pre-test and Post-test Results on Students' Research Skills**

The paired samples t-test results show a statistically significant improvement in all research skill areas after exposure to the Cognitive Apprenticeship Strategy (CAS), with p-values of 0.000 across all paired comparisons: objective formulation (OB–OA), literature review writing (LRB–LRA), and methodology development (MB–MA). This indicates that the observed gains are statistically significant and attributable to the intervention.

Table 3: Joint Display of Grade 8 STE Students' Research Skills After CAS

| **Research Skill** | **Quantitative Results** | | | | **Qualitative Results** | |
|---|---|---|---|---|---|---|
| Pair | Mean | SD | T | P | Themes | Confirmatory Statements |
| OB-OA | -7.50000 | 2.37953 | -19.430 | 0.000 | Improved skills through examples, feedback, and hands-on activities | "Through demonstrations, I learned how to write SMART objectives" |
| LRB-LRA | -6.52632 | 2.50121 | -16.085 | 0.000 | Improved skills through examples, feedback, and hands-on activities | "I learned how to write RRL with citations" |
| MB-MA | -7.13158 | 2.06870 | -21.251 | 0.000 | Improved skills through examples, feedback, and hands-on activities | "I learned how to align procedures to objectives." |

Legend: ** - *significant at 0.05 level*

| | |
|---|---|
| Objective-Before | OB |
| Objective-After | OA |
| Literature Review-Before | LRB |
| Literature Review-After | LRA |
| Methods-Before | MB |
| Methods-After | MA |

However, to determine the practical significance of these improvements, Cohen's d was computed as a measure of effect size. The results showed very large effect sizes across all domains, specifically, objective formulation (d = 3.15), literature review writing (d = 2.61), and methodology development (d = 3.45). These values indicate that the Cognitive Apprenticeship Strategy had a strong practical impact on students' research skill development beyond statistical significance.

Specifically, all domains showed significant improvement, with the greatest gain observed in methodology development, followed by objective formulation and literature review writing. These results suggest that CAS effectively enhanced students' ability to structure research objectives, synthesize literature, and design methodologies. Similar findings report that scaffolded and structured instruction significantly improves students' research writing and higher-order thinking skills (De La Paz et al., 2022; Hilary et al., 2022).

Qualitative findings support these results, as students reported improved understanding of research tasks through demonstrations, feedback, and hands-on activities. They noted better performance in writing SMART objectives

(OB–OA), using citations in literature reviews (LRB–LRA), and aligning procedures with objectives (MB–MA). This reflects Cognitive Apprenticeship principles of modeling, scaffolding, and coaching (Collins et al., 1989; National Research Council, 2012).

Overall, the findings confirm that CAS significantly improved students' research competencies across all domains, consistent with evidence that guided and scaffolded learning enhances research literacy and procedural understanding among learners (Cuayzon, 2024; Freitas et al., 2023; Lagulos, 2025).

### Limitations of The Study

This study acknowledges several threats to internal validity due to the use of a one-group pretest–posttest design. Specifically, history effects may have influenced students' performance due to external learning experiences outside the intervention period. Maturation effects may also have contributed, as students naturally develop cognitive and academic skills over time. Additionally, testing effects cannot be ruled out, as exposure to the pretest may have influenced students' familiarity with the research tasks in the posttest.

Because the study did not include a control group, it is not possible to fully isolate the effects of the Cognitive Apprenticeship Strategy (CAS) from these threats. Future studies are recommended to employ a non-equivalent control group design or randomized controlled design to strengthen causal inferences and improve internal validity.

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

Grade 8 STE students showed low to developing research skills in objective formulation, literature review writing, and methodology development before the intervention. After exposure to the Cognitive Apprenticeship Strategy (CAS), students demonstrated significant improvement across all research skill areas, supported by higher post-test scores and qualitative evidence of enhanced understanding through guided instruction and practice. The significant difference between pre-test and post-test results indicates that CAS is an effective strategy in improving students' research competencies.

### Recommendations

Teachers are encouraged to apply the Cognitive Apprenticeship Strategy in research instruction through modeling, scaffolding, coaching, and guided practice. School administrators should support its implementation by providing training and instructional resources. Students should actively participate in guided research activities to further develop their skills. Curriculum planners may consider integrating CAS into the STE curriculum to strengthen research literacy and higher-order thinking skills. Future researchers are encouraged to replicate the study in other contexts to further validate its effectiveness.

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