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PAGTUKLAS: Prior Art-Guided Tutorials by Using Digital Knowledge to Learn and Apply Searching Strategies

Rosalie Brina[1], Mary Joy P. Emiliano[2], Michell M. Lami[3], Jenie D. Magbasa[4], Bea C. Soriano[5], Juhannie M. Suganan[6], Myla P. Versonda[7]

[1,2,3,4,5,6]Student, Bachelor of Technology and Livelihood Education major in Home Economics, Faculty of Teacher Education, Davao Oriental State University, Mati City, Davao Oriental, Philippines
[7]Associate Professor, Faculty of Teacher Education, Davao Oriental State University, Mati City, Davao Oriental, Philippines

Abstract

This classroom-based action research examined the effectiveness of PAGTUKLAS (Prior Art-Guided Tutorials by Using Digital Knowledge to Learn and Apply Searching Strategies), an interactive Genially-based tutorial, in improving the prior art searching skills of third-year Bachelor of Technology and Livelihood Education (BTLEd) students majoring in Home Economics and Industrial Arts at Davao Oriental State University. A needs survey and diagnostic test showed that students had difficulty generating keywords, constructing Boolean search strings and navigating patent databases, which root cause analysis traced to a lack of prior knowledge and difficulty navigating patent databases. The tutorial guided students through seven locked levels, from writing a one-sentence invention summary to analyzing patent abstracts and was implemented with 71 students over four weeks in two action research cycles, the second using a revised version. Data were gathered through a pretest and posttest scored with a validated rubric, a confidence rating scale, interviews and observation notes. The mean score rose from 27.00 (SD = 11.14) to 52.68 (SD = 9.86) out of 60, and the number of students reaching the 75% passing score rose from 4 (5.63%) to 60 (84.51%). The gain was statistically significant, $t(70) = 16.08$, $p < 0.001$, with a large effect size (Cohen's $d = 1.91$). Mean confidence rose from 3.10 (moderately confident) to 3.97 (confident), although confidence was not related to posttest performance ($r = 0.02$), and nine of the 11 students who did not pass rated themselves as confident. Interviews described the tutorial as useful and its revised version as easier to use, and eight implementation challenges were addressed between cycles. PAGTUKLAS offers a low-cost, replicable approach to teaching prior art searching in teacher education.

Keywords: PAGTUKLAS, Prior Art Searching, Patent Databases, Boolean Search Strategies, Genially, TPACK, Action Research, Pre-Service Teachers

1. Introduction

The Commission on Higher Education (CHED) encourages higher education institutions to conduct research that contributes to national development [1]. In the Bachelor of Technology and Livelihood Education (BTLEd) program, Technology Research 1 (BTLE-R117) is a professional education course that serves as the foundation for Technology Research 2 [2]. In this course, third-year Home Economics (HE) and Industrial Arts (IA) students are expected to propose novel food technologies and technology-based projects, supported by topics on research foundations, problem formulation, patent analysis and innovation, process design and evaluation, market and feasibility analysis, and technical documentation.

Although students take Practical Research 1 in senior high school, that course introduces only basic research concepts, qualitative designs and data collection [3]. Technology Research 1, by contrast, demands applied skills such as prior art searching, patent analysis and process design that students have not practised before. Classroom instruction tends to emphasize content coverage over competency building, so students receive little structured practice in keyword selection, search strategies and the use of patent databases. The gap becomes evident when students move from theory to digital patent tools and find it difficult to conduct independent searches and build meaningful search strings. Prior art searching matters because uncovering existing inventions early allows researchers to modify an invention, reduce later risks and make better decisions about whether to pursue it [4]; without this skill, students risk duplicating existing inventions and writing proposals with weak claims of novelty.

Diagnostic data collected at Davao Oriental State University (DOrSU) confirmed the problem. In a needs survey in September 2025, Prior Art Search was ranked the most difficult Technology Research 1 topic by 23 of 37 HE 3 respondents (62.2%) and by 9 of 22 IA 3 respondents (40.9%). Classroom observations recorded in the researchers' field notes showed that students relied heavily on peers, frequently asked for clarification of directions and had limited skill in navigating patent databases and creating search strings, and students interviewed in August 2025 described difficulty identifying keywords and using Boolean search strings and patent databases. The pretest administered before the intervention showed that 67 of 71 students (94.37%) scored below the 75% passing score.

This action research therefore implemented PAGTUKLAS (Prior Art-Guided Tutorials by Using Digital Knowledge to Learn and Apply Searching Strategies), an interactive tutorial developed on the Genially platform. PAGTUKLAS guides students step by step through keyword generation, Boolean search strings, patent classification and database navigation, and addresses the root causes of students' difficulties that lie within the teacher's control.

1.1 Problem Statement

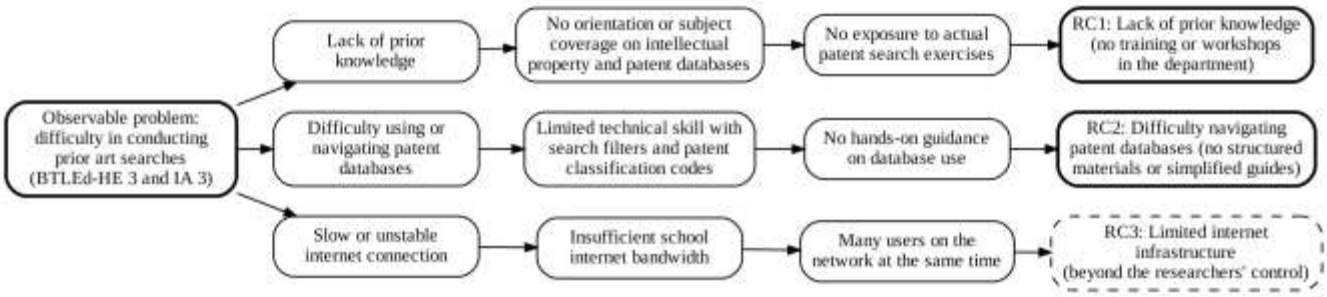
A large proportion of third-year BTLEd-HE and BTLEd-IA students had difficulty conducting prior art searches in Technology Research 1. They struggled to generate precise keywords, used the Boolean operators AND, OR and NOT incorrectly or not at all, and had difficulty using the filters and classification fields of patent databases such as Espacenet and Google Patents, which produced irrelevant or overly narrow results. These skill gaps weaken core tasks of Technology Research 1, including reviewing existing work, identifying research gaps and avoiding duplicated studies, and lead to research proposals with weak novelty claims and less defensible justifications.

1.2 Root Cause Analysis

A root cause analysis using the Why-Why technique traced the problem from its observable symptoms to its root causes (Figure 1), using data from interviews, the needs survey, the diagnostic test and classroom observation. Three causal chains were identified. Students lacked prior knowledge because

the curriculum offered no orientation on intellectual property and patent databases and no actual patent search exercises; they had difficulty navigating patent databases because they lacked technical skill with search filters and classification codes and received no hands-on guidance or simplified guides; and they were affected by slow or unstable internet connections because school bandwidth was insufficient for the number of users.

Figure 1: Why-Why Diagram Tracing the Causal Chain from the Observable Problem to the Root Causes



Each probable root cause was checked against evidence and assessed for controllability (Table 1). Two root causes were validated as within the teacher's control and became the targets of the intervention: Root Cause 1 (RC1), lack of prior knowledge, as students had no experience in prior art searching and the topic was new to them; and Root Cause 2 (RC2), difficulty in using or navigating patent databases such as Google Patents and Espacenet, as students lacked the technical skill and guided practice needed to operate these platforms. Slow internet connection (RC3) was confirmed but excluded because it is beyond the researchers' control; its effects were instead managed through a contingency plan described in Section 2.6.

Table 1: Root Cause Validation Matrix

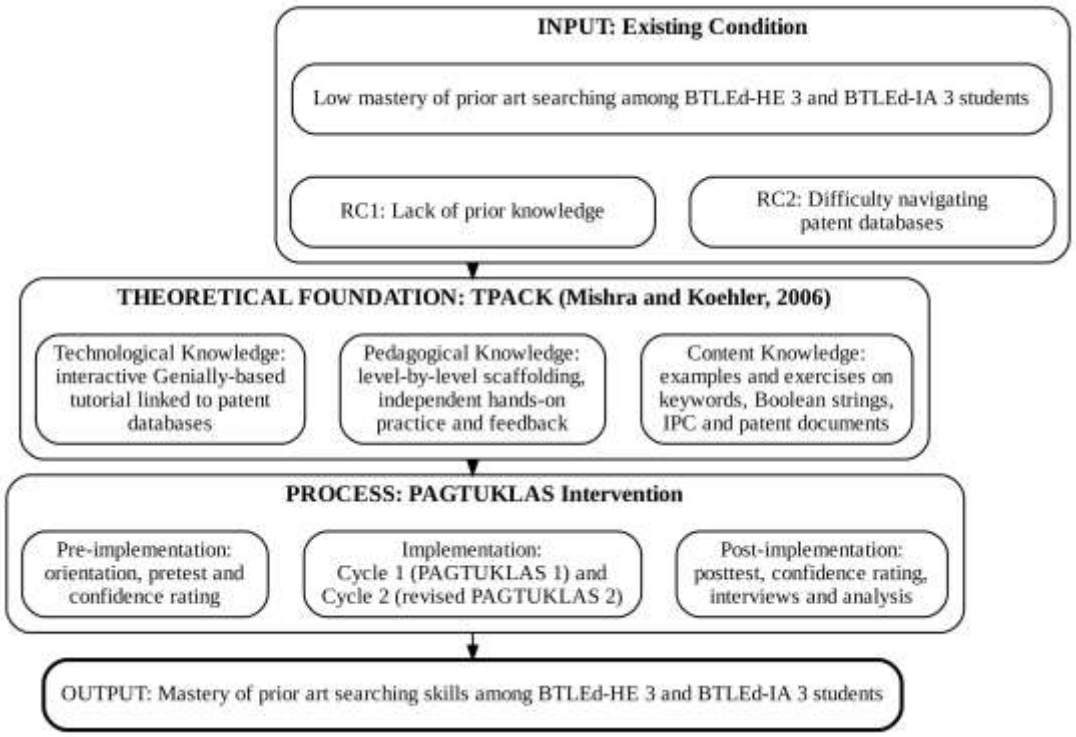
Probable Root Cause	Validation	Evidence Source	Controllability	Conclusion	Priority
RC1: Lack of prior knowledge	True	Survey test, student interviews	Within control	Valid	High
RC2: Difficulty navigating patent databases	True	Observation, survey test	Within control	Valid	High
RC3: Slow internet connection	True	Student survey, observation	Beyond control	Excluded from the intervention	Medium

1.3 Conceptual Framework

The study is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, which holds that effective teaching with technology integrates knowledge of technology, pedagogy and content [5], [6]. In PAGTUKLAS, Technological Knowledge is represented by the interactive features of the tutorial, which link directly to patent databases and simulate authentic search procedures;

Pedagogical Knowledge by the level-by-level scaffolding, independent hands-on practice and feedback that support self-directed learning; and Content Knowledge by examples and exercises on keywords, Boolean strings, the International Patent Classification (IPC) and patent documents. The intervention also applies the principles of formative assessment, using continuous feedback and progress monitoring to improve learning [7]: students cannot advance to the next level until they have completed the current one, and the tutorial was revised between cycles on the basis of students' performance and feedback. Figure 2 shows how the validated root causes (input) are addressed through the TPACK-based intervention (process) to produce mastery of prior art searching skills (output).

Figure 2: Conceptual Framework of the Study



1.4 Research Questions and Hypothesis

The study addressed the central question: How does the implementation of PAGTUKLAS affect the mastery of prior art searching skills among third-year BTLEd-HE and BTLEd-IA students? Specifically, it sought to answer the following questions:

1. What is the students' level of competence in prior art searching before the use of the interactive Genially-based tutorial?
2. How does the intervention affect students' mastery of prior art searching skills before and after the implementation?
3. What is the students' level of confidence in conducting prior art searches before and after the use of the tutorial?
4. What are the students' perceptions of the effectiveness, usability and relevance of PAGTUKLAS?
5. What implementation challenges emerge during the intervention, and how are they addressed through the action research cycle?

For Research Question 2, the null hypothesis tested at the 0.05 level was that there is no significant difference between the students' pretest and posttest scores in prior art searching.

1.5 Scope, Delimitation and Limitation

The study covered third-year BTLEd-HE and BTLEd-IA students officially enrolled in Technology Rese-
arch 1 (BTLE-R117) at the DOrSU Main Campus in the first semester of Academic Year 2025–2026, regardless of age or gender. It focused on three skills: identifying appropriate keywords, constructing Boolean search strings and navigating patent databases (Espacenet, Google Patents and WIPO Patentscope, which were linked in the tutorial). The intervention lasted four weeks and measured skill improvement within that period; long-term retention was not assessed. The findings may be affected by the limited time per session, students' differing familiarity with digital tools, the need for internet access, and students' honesty, motivation and pace when working through the tutorial, and they apply only to the participating classes.

1.6 Significance of the Study

The study gives students a structured way to develop prior art searching skills and confidence in locating relevant patent and research documents. It gives teachers a ready digital resource for teaching keyword identification, Boolean search strings and database navigation, and gives administrators a low-cost model for integrating technology into research instruction in line with CHED's mandate to promote research-based learning. By strengthening originality and reducing duplicated work, the study also supports research integrity in the academic community and prepares graduates to support innovation in their communities and in industry.

2. Methodology

2.1 Research Design

The study used a classroom-based action research design with an embedded mixed-methods model, in which the quantitative strand is dominant and the qualitative strand supports and explains the quantitative results [8]. Quantitative data came from a pretest and posttest of prior art searching skills and from a confidence rating scale given before and after the intervention. Qualitative data came from semi-structured interviews and the researchers' observation notes collected throughout the four weeks. The intervention was carried out in two action research cycles: Cycle 1 used the first version of the tutorial (PAGTUKLAS 1), and Cycle 2 used a revised version (PAGTUKLAS 2) based on the Cycle 1 interviews and observations.

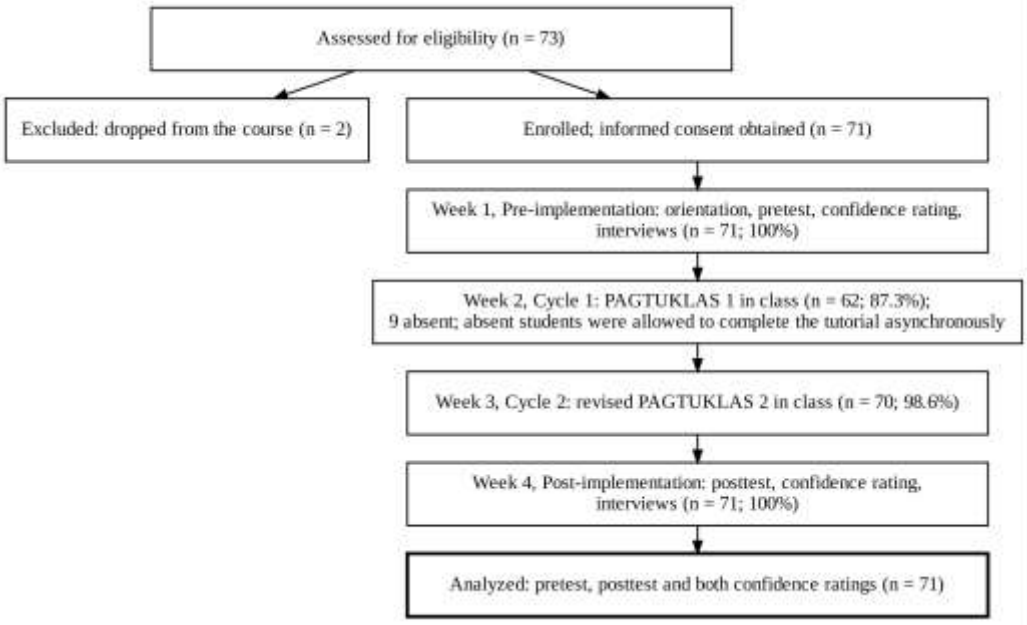
2.2 Participants

The participants were two intact classes of third-year BTLEd students enrolled in Technology Research 1 in Academic Year 2025–2026: 38 HE students and 33 IA students (Table 2). They were selected purposively, because the needs survey, interviews and diagnostic test showed that these classes had difficulty with prior art searching [9]. Of the 73 students assessed for eligibility, two dropped the course, and all 71 remaining students gave informed consent and completed the pretest, the posttest and both confidence ratings. Attendance during the in-class tutorial sessions was 62 students (87.3%) in Week 2 and 70 students (98.6%) in Week 3; absent students were allowed to complete the tutorial asynchronously (Figure 3) [10].

Table 2: Demographic Profile of the Participants (n = 71)

Characteristic	Category	Frequency	Percentage
Major	Home Economics (BTLEd-HE 3)	38	53.52
	Industrial Arts (BTLEd-IA 3)	33	46.48
Year level	Third year	71	100.00
Course	BTLE-R117 Technology Research 1	71	100.00

Figure 3: Participant Flow and Attendance Across the Four Weeks of Implementation



2.3 Research Instruments

Four instruments were used (Table 3). The Prior Art Searching Skill Test, aligned with Learning Outcome 2 (prior art search) of the BTLE-R117 syllabus, presented the abstract of a patented invention (a foldable kitchen utility stand) and asked students to identify keywords, form a Boolean search string, search any patent database and record three related prior art documents. Each entry was scored with a six-criterion rubric worth 20 points (Table 4), giving a total of 60 points for the three entries. The same test was used as the pretest and the posttest. The confidence rating scale asked students to rate their confidence in five prior art searching skills from 1 (no confidence) to 5 (very confident). The interview guide asked about students' experience of the tutorial, the skills they learned, its ease of use, problems encountered and suggested improvements, and the observation notes recorded participation, navigation problems and technical or procedural difficulties.

The test and rubric were validated by three faculty members with expertise in the subject, including the research adviser, using validation sheets for the rubric and the test items. The initial version of the rubric received an overall rating of 77% (Satisfactory, accept with revisions), with the lowest ratings for performance-level descriptors and reliability considerations. The descriptors were then made more specific and observable, overlapping criteria were clarified and the layout was improved, after which the revised rubric received an overall rating of 87% (Exemplary, accept with minor editing).

Table 3: Research Instruments

Instrument	Purpose	Format and Scoring	Analysis
Prior Art Searching Skill Test (pretest and posttest)	Measure competence in prior art searching (Learning Outcome 2)	Three prior art entries for one invention abstract, each scored with a 20-point rubric (total 60)	Descriptive statistics, paired-sample t-test, effect size
Confidence rating scale	Measure self-assessed confidence in five prior art searching skills	Five items rated 1 (no confidence) to 5 (very confident)	Frequencies, means, comparison with test scores
Semi-structured interview	Capture perceptions of the tutorial, challenges and learning	Guide questions after Cycle 1 and Cycle 2	Inductive thematic analysis
Researcher observation notes	Document implementation, engagement and challenges	Field notes and tallies of observed behaviors	Narrative and frequency analysis

Table 4: Scoring Rubric for Each Prior Art Entry (20 points)

Criterion (Points)	Excellent (Full Points)	Satisfactory (Half Points)	Poor (No Points)
Keywords developed (4)	All three keywords are relevant and precise	Some keywords relevant but general or partially connected	Keywords missing, irrelevant or unrelated
Search string (4)	Correct use of Boolean operators and synonyms	Boolean operators used but synonyms missing or minor errors	Missing or incorrect Boolean search string
Title (2)	Title fully matches the invention	Title partially correct or incomplete	Title missing or unrelated
Publication number and date (2)	Both provided and accurate	Only one provided or partially correct	Both missing or incorrect
International Patent Classification (2)	IPC provided correctly and relevant	IPC partially correct or generic	IPC missing or incorrect
Relation to abstract (6)	Clear, concise explanation showing deep understanding of the relation	Explanation vague, incomplete or partially correct	No explanation or irrelevant relation

2.4 Data Analysis

Pretest and posttest scores were analyzed with descriptive statistics (mean, standard deviation, median,

mode, range, skewness and kurtosis) and compared with a paired-sample t-test at the 0.05 level of significance. Effect size was computed as Cohen's d for paired samples (mean gain divided by the standard deviation of the gains) and as eta squared, interpreted with Cohen's benchmarks [11]. A score of 45 out of 60 (75%) was used as the passing score, following the passing grade used in Philippine schools [12]. Confidence ratings were summarized as frequencies and means, and each mean was interpreted by the nearest scale point (1.00–1.49 no confidence, 1.50–2.49 slightly confident, 2.50–3.49 moderately confident, 3.50–4.49 confident, 4.50–5.00 very confident). To examine how well confidence matched performance, each student's average post-intervention confidence was compared with the posttest score converted to the same five-point scale (percentage score ÷ 20), and the two were correlated with Pearson's r.

Interview and observation data were transcribed verbatim and analyzed through inductive qualitative content analysis in four stages: selecting content, collecting and storing, analysis and write-up [13]. Initial codes were generated from the data rather than from predetermined categories [14]; each researcher coded selected transcripts independently, differences were resolved through discussion until consensus was reached, and the codes were compiled into a codebook with labels, definitions and examples. Codes were then grouped into themes, which were reviewed through peer debriefing [15] and linked to the research questions. Observation notes were analyzed through narrative and frequency analysis of the challenges observed. Trustworthiness was supported by triangulation of tests, rating scales, interviews and observation notes [16], member checking of preliminary interpretations with selected participants [17], an audit trail of protocols, coding decisions and revisions [18], and prolonged engagement with the students across the four weeks [19].

2.5 Procedure for Implementation and Monitoring

The intervention followed a four-week timeline (Table 5). In Week 1, students were oriented on the objectives and procedure of the study and introduced to the Genially tutorial and to patent databases such as Google Patents and Espacenet, and the pretest, the first confidence rating and short interviews were administered. In Week 2 (Cycle 1), the researchers demonstrated the tutorial, after which students worked through PAGTUKLAS 1 individually while the researchers observed their participation and navigation; interviews at the end of the cycle identified parts of the tutorial that needed improvement. In Week 3 (Cycle 2), the Cycle 1 observations and interview responses were analyzed, the tutorial was revised, and students completed PAGTUKLAS 2 under continued observation, followed by interviews. In Week 4, the posttest, the second confidence rating and final interviews were administered, and all data were compiled and analyzed.

Table 5: Implementation Timeline

Phase	Period	Key Activities	Responsible
Pre-implementation (Week 1)	November 18 and 20, 2025	Orientation; introduction to the tutorial and patent databases; pretest; confidence rating; baseline observation; initial interviews	Researchers, students
Implementation, Cycle 1 (Week 2)	November 24, 25 and 27, 2025	Guided demonstration; PAGTUKLAS 1; observation; interviews	Researchers, students

Phase	Period	Key Activities	Responsible
Implementation, Cycle 2 (Week 3)	December 1, 2, 4 and 5, 2025	Analysis of Cycle 1 data; revision of the tutorial; PAGTUKLAS 2; observation; follow-up interviews	Researchers, students
Post-implementation (Week 4)	December 8, 2025	Posttest; confidence rating; final interviews; analysis and reporting	Researchers, students

2.6 Ethical Considerations and Risk Management

Before data collection, the purpose and procedures of the study and the data to be collected were explained to the students during the orientation, and their verbal informed consent was obtained; the study was conducted with the approval of the subject teacher as part of regular class activities. Each participant was assigned a code, personal identifiers were removed from all research records and reports, digital data were stored on a password-protected computer and paper documents in a locked cabinet accessible only to the researchers and the adviser, and all data will be destroyed five years after the study. A risk assessment rated time constraints from overlapping academic schedules as the highest risk, followed by limited student engagement and unstable internet connections. These were addressed through flexible schedules coordinated with the subject teacher, engaging interactive activities, asynchronous access to the tutorial, PDF materials and pre-recorded video tutorials for offline study, and pilot testing of the tutorial to correct unclear instructions.

3. The PAGTUKLAS Intervention

3.1 Components of the Tutorial

PAGTUKLAS breaks prior art searching into manageable, sequential steps that students master at their own pace. The interactive Genially tutorial is organized into seven levels (Table 6). Each level is locked until the previous level is completed, so students build basic concepts before applying them. The tutorial uses concept mapping to help students connect their own ideas to the search, interactive displays and practical exercises to show how Boolean operators and IPC codes narrow or widen search results, QR codes and links that open patent databases such as Espacenet and Google Patents for guided practice, and analytical exercises on patent abstracts. The early levels build the prior knowledge that students lacked (RC1), and the later levels give guided practice in navigating patent databases (RC2).

Table 6: Levels of the PAGTUKLAS Interactive Tutorial

Level	Focus	Main Activity
1	Writing a one-sentence invention summary	State the purpose, main components and function of the invention
2	Creating keywords	Extract the key terms from the invention summary
3	Brainstorming keywords and synonyms	Expand each key term with synonyms and related technical terms
4	Boolean operators and IPC	Combine terms with AND, OR and NOT and identify relevant IPC codes

Level	Focus	Main Activity
5	Knowing patent databases	Explore the features and filters of linked patent databases
6	Exploring deeper using IPC	Search a chosen patent database using IPC codes and filters
7	Analyzing the abstract	Answer questions comparing the retrieved documents with the invention

Implementation proceeded in three phases. In orientation and exploration, students were introduced to the features and objectives of the tutorial and explored its interface with guidance. In application and skill integration, they completed assigned search tasks, first with detailed instructions and then without step-by-step guidance, and recorded and summarized their results. In adjustment and completion, they received additional feedback and consultation until they had completed all levels.

3.2 Resources, Quality Assurance and Sustainability

The researchers designed, implemented and evaluated the tutorial and collected and analyzed the data, with support from the Technology Research 1 instructor; students used their own smartphones or laptops with campus Wi-Fi or mobile data, and PDF materials were provided for offline study. The study cost Php 10,713.50, funded by the researchers: Php 8,270.00 for developing the instructional materials, including Php 7,070.00 for an annual Genially Pro subscription; Php 1,943.50 for printing and completion incentives; and a Php 500.00 contingency fund. Implementation fidelity was monitored through protocol checks, attendance and engagement tracking and checks on students' use of the patent databases, and weekly outputs and feedback were used to revise the tutorial. The process indicator of success was at least 90% student participation and task completion. The outcome indicator was a 70% improvement in prior art searching ability, which the authors defined as the proportion of students who demonstrated improvement in this skill and greater confidence in using patent databases. For sustainability, a teacher's guide to PAGTUKLAS will be prepared, and the tutorial can be adapted to other research courses and to the school's available resources and connectivity.

4. Results and Discussion

4.1 Competence in Prior Art Searching Before the Intervention

Before the intervention, pretest scores ranged from 0 to 50 out of 60, with a mean of 27.00 (SD = 11.14), equivalent to 45.00% (Table 7). Only four students (5.63%) reached the passing score of 45, while 67 (94.37%) did not. The skewness (−0.11) and kurtosis (−0.46) show that the pretest scores were approximately normally distributed. These results confirm that most students lacked the basic skills of prior art searching before the intervention.

Table 7: Descriptive Statistics of the Pretest and Posttest Scores (n = 71; total score = 60)

Statistic	Pretest	Posttest
Mean (percentage)	27.00 (45.00%)	52.68 (87.79%)
Standard deviation	11.14	9.86

Statistic	Pretest	Posttest
Standard error	1.32	1.17
Median	28	57
Mode	18	60
Minimum–maximum (range)	0–50 (50)	13–60 (47)
Skewness	−0.11	−1.96
Kurtosis	−0.46	4.56
Passed (score ≥ 45)	4 (5.63%)	60 (84.51%)
Did not pass (score < 45)	67 (94.37%)	11 (15.49%)

Before the intervention, students rated themselves as moderately confident in all five skills, with means from 3.00 for creating effective search strategies to 3.18 for using patent databases effectively (Table 8). This moderate confidence contrasts with the low pretest performance, which shows that students overestimated their competence before they had practised prior art searching.

Table 8: Confidence Ratings Before and After the Intervention (n = 71)

Skill	Before: f (1/2/3/4/5)	Mean	Level	After: f (1/2/3/4/5)	Mean	Level
Understanding what constitutes prior art	0 / 15 / 37 / 19 / 0	3.06	Moderately confident	0 / 3 / 14 / 42 / 12	3.89	Confident
Using patent databases effectively	0 / 16 / 28 / 25 / 2	3.18	Moderately confident	0 / 2 / 10 / 36 / 23	4.13	Confident
Creating effective search strategies	1 / 16 / 36 / 18 / 0	3.00	Moderately confident	0 / 1 / 18 / 34 / 18	3.97	Confident
Evaluating search results	1 / 13 / 35 / 21 / 1	3.11	Moderately confident	0 / 2 / 17 / 39 / 13	3.89	Confident
Knowing when to stop searching	1 / 13 / 36 / 17 / 4	3.14	Moderately confident	0 / 3 / 14 / 37 / 17	3.96	Confident
Overall		**3.10**	**Moderately confident**		**3.97**	**Confident**

4.2 Effect of the Intervention on Prior Art Searching Skills

After the intervention, posttest scores ranged from 13 to 60, with a mean of 52.68 (SD = 9.86), equivalent to 87.79% (Table 7). Sixty students (84.51%) passed, and 30 (42.25%) obtained the maximum score of 60. Seventy of the 71 students improved; one student (P2) scored lower on the posttest (21) than on the pretest (30). Because many students reached the maximum score, the posttest distribution was negatively skewed (−1.96) and more peaked than a normal distribution (kurtosis =

4.56). The paired-sample t-test, however, depends on the distribution of the differences between the two scores, and these were approximately normal (Shapiro–Wilk $W = 0.98$, $p = 0.26$).

The paired-sample t-test showed that the difference between the pretest and posttest scores was statistically significant, $t(70) = 16.08$, $p < 0.001$ (two-tailed), so the null hypothesis was rejected (Table 9). The mean gain was 25.68 points (95% confidence interval: 22.49 to 28.86). Cohen's d for paired samples was 1.91 and eta squared was 0.79, both large effects [11]. The correlation between the pretest and posttest scores was weak ($r = 0.18$), which shows that the gains were not limited to students who started with higher scores.

Table 9: Paired-Sample t-Test of Pretest and Posttest Scores (n = 71)

Test	Mean	SD	Mean Gain (95% CI)	t	df	p (two-tailed)	Cohen's d	η^2	Decision
Pretest	27.00	11.14	25.68	16.08	70	< 0.001	1.91	0.79	Reject H0
Posttest	52.68	9.86	(22.49 to 28.86)				(large)	(large)	

The posttest entries still showed some weaknesses: some search strings contained errors in Boolean logic or typographical mistakes, some explanations of relevance were general and did not refer to specific features of the invention, and some searches could have used more synonyms or technical terms. Eleven students did not reach the passing score (Table 10). Ten of them improved, some by as much as 30 points, but stayed below 45, while P2 scored lower than on the pretest. According to the observation notes, these students were often late for or absent from the scheduled sessions, which reduced their exposure to the guided parts of the tutorial, and in the interviews they reported difficulty applying Boolean logic and selecting appropriate keywords. Catch-up sessions, guided practice in forming search strings, step-by-step demonstrations of database navigation and individual feedback on their errors are recommended for these students.

4.3 Confidence in Conducting Prior Art Searches

After the intervention, the students rated themselves as confident in all five skills (Table 8). The overall mean rose from 3.10 to 3.97, and the highest rating was again for using patent databases effectively (4.13). Understanding what constitutes prior art and evaluating search results had the lowest means (3.89), which suggests that conceptual understanding and critical evaluation need more reinforcement than the procedural skills.

Higher confidence did not, however, mean that students judged their own skill accurately. The correlation between average post-intervention confidence and posttest scores was close to zero ($r = 0.02$, $p = 0.88$; Figure 4). Among the 11 students who did not pass, nine rated their confidence higher than their posttest performance, with the largest gaps for P54 (+3.52), P2 (+2.25) and P69 (+2.17), while two (P14 and P18) rated themselves slightly lower than their performance (Table 10). These results point to limited metacognitive accuracy in a subset of learners and suggest that calibration activities, such as guided reflection and comparison of expected and actual results, should accompany the tutorial.

Figure 4: Average Post-Intervention Confidence Rating and Posttest Score of Each Student

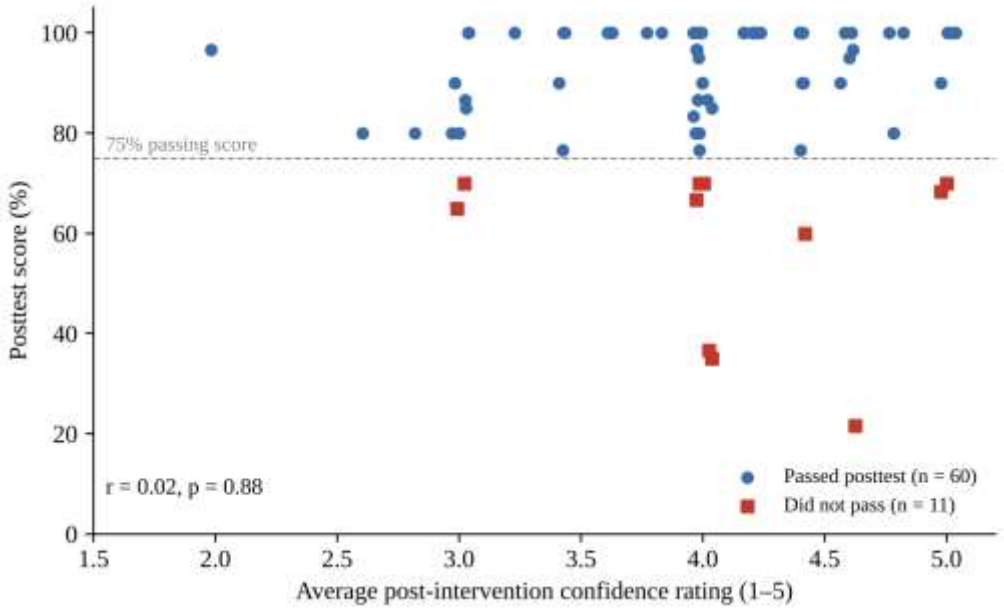


Table 10: Scores and Confidence of the Students Who Did Not Pass the Posttest (n = 11)

Student	Pretest	%	Posttest	%	Average Confidence	Discrepancy	Direction
P2	30	50.00	21	35.00	4.00	+2.25	Overconfident
P13	30	50.00	42	70.00	4.00	+0.50	Overconfident
P14	20	33.33	42	70.00	3.00	−0.50	Underconfident
P18	30	50.00	39	65.00	3.00	−0.25	Underconfident
P27	32	53.33	42	70.00	4.00	+0.50	Overconfident
P47	12	20.00	42	70.00	5.00	+1.50	Overconfident
P48	28	46.67	36	60.00	4.40	+1.40	Overconfident
P53	21	35.00	41	68.33	5.00	+1.58	Overconfident
P54	10	16.67	13	21.67	4.60	+3.52	Overconfident
P69	21	35.00	22	36.67	4.00	+2.17	Overconfident
P71	30	50.00	40	66.67	4.00	+0.67	Overconfident

Note: Discrepancy = average post-intervention confidence − (posttest percentage ÷ 20). A positive value indicates overconfidence and a negative value underconfidence.

4.4 Students' Perceptions of PAGTUKLAS

Thematic analysis of the interviews identified five themes after Cycle 1 and two themes after Cycle 2 (Table 11). After Cycle 1, students described PAGTUKLAS as useful and engaging and as a tool that made prior art searching easier and faster. They reported learning new search strategies, particularly the Boolean operators OR and NOT in addition to AND. They rated its ease of use as moderate, neither easy

nor difficult, mainly because the answer boxes allowed only a limited number of characters, and they asked for longer answers to be allowed. After Cycle 2, students reported that the revised tutorial removed these limitations and was easier to follow because it was broken into clear steps, and they described it as a helpful guide for identifying the correct prior art for their proposed inventions. These perceptions show that the tutorial was seen as relevant and effective, and that the revisions between cycles improved its usability.

Table 11: Themes from the Interviews After PAGTUKLAS 1 and PAGTUKLAS 2

Cycle	Theme	Sample Response (English translation)
1	Perceived usefulness and engagement	"For me, PAGTUKLAS was a big help. It is like an app… it really helps us make searching for prior art easier." (P16)
1	Development of search strategy skills	"What I learned is the use of Boolean operators. At first we only used AND, but there are also NOT and OR." (P19)
1	Moderate ease of use	"I can't say it is easy, and I can't say it is difficult either, but it is helpful." (P43)
1	Technical and system-related challenges	"The characters are limited; you cannot type your whole answer." (P7)
1	Areas for system improvement	"What I want improved is being able to enter all the words that need to be entered, even if the answer is long." (P6)
2	Improved functionality and navigation	"Before, only a little could fit in the box; in the new one, thousands [of characters] fit… It is very easy to find prior art because it is broken into pieces, step by step, from finding synonyms to creating the search string to the last process. That is why it was easier for me the second time." (P3)
2	Positive user experience and satisfaction	"In my view, it is good and a big help for prior art searching. It served as our guide to know the correct prior art for the invention or project we want to propose." (P35)

4.5 Implementation Challenges and Refinements

The observation notes recorded eight implementation challenges, each observed in two to four students (Table 12). Most concerned navigation, platform limitations and accessibility rather than understanding of prior art searching. Each challenge was addressed through a mini action research cycle of observation, reflective analysis, planned modification, implementation and evaluation, and the modifications were built into PAGTUKLAS 2. The most important change was the upgrade to Genially Pro, which raised the answer limit from 40 to about 1,000 characters; in Cycle 1, many students had to write their answers on paper. In Cycle 2, the observation notes recorded smoother navigation, fewer navigation errors, more complete written responses and fewer reports of visual discomfort. Unstable internet connection, the root cause excluded from the intervention, was managed by allowing students to complete the tutorial at home or wherever the connection was stronger.

Table 12: Implementation Challenges Observed in Cycle 1 and Modifications in Cycle 2

Challenge	f	Modification in Cycle 2
Difficulty navigating the tutorial and moving to the next level	4	Clearer step-by-step instructions and navigation cues, with researcher guidance
Low confidence and hesitation in applying search strategies	3	Guided support and real-time feedback during tutorial activities
Absenteeism and tardiness	2	Asynchronous completion at the student's own pace, monitored through Genially and the class group chat
Character limit of 40 in answer boxes	2	Upgrade to Genially Pro, allowing about 1,000 characters per response
Wrong location icon clicked on the map page	2	Color-coded icons: blue for completed, yellow for the next accessible and red for locked levels
Answers lost after an incorrect attempt, forcing a restart	2	Answer-saving (drafting) feature so that students can review and edit previous answers
Researchers unable to verify who completed the tutorial	2	Answer fields converted into forms requiring the student's name and section
Small fonts and colors that were hard to read	2	Larger font sizes and complementary, high-contrast colors

4.6 Discussion

The results show that PAGTUKLAS substantially improved students' prior art searching skills. The proportion of students reaching the passing score rose from 5.63% to 84.51%, the mean gain was more than 25 points out of 60, and the effect size was large. These results are consistent with the TPACK framework [5], [6]: the tutorial combined technology (an interactive platform linked to real patent databases), pedagogy (locked, scaffolded levels with independent practice) and content (keywords, Boolean logic, IPC and patent documents) into a single learning experience, which directly targeted the lack of prior knowledge (RC1) and the difficulty of navigating patent databases (RC2). The revisions between the two cycles reflect the principles of formative assessment [7], as students' difficulties and feedback in Cycle 1 led to changes that students recognized as improvements in Cycle 2. The interviews and observation notes help explain the quantitative gains, as students attributed their progress to the step-by-step structure and to learning how to use Boolean operators.

The confidence results add an important qualification. Although confidence rose from moderate to confident, it was unrelated to actual performance both before and after the intervention, and most of the students who did not pass were overconfident. Teaching prior art searching therefore requires not only practice with search tools but also feedback that helps students judge the quality of their own searches.

These findings should be interpreted with caution. The study used two purposively selected classes without a comparison group, so the improvement cannot be attributed to PAGTUKLAS alone; regular coursework and maturation may also have contributed. The same test and invention abstract were used for the pretest and the posttest about three weeks apart, so familiarity with the abstract may have raised posttest scores, and 30 students reached the maximum score, which limits the measurement of the

highest performers. The researchers implemented the intervention and scored the tests, one of the rubric validators was the research adviser, and no inter-rater agreement in scoring was computed. Confidence was self-reported, and some students completed the tutorial outside class, where their work could not be observed.

5. Conclusion

PAGTUKLAS effectively improved the prior art searching skills of third-year BTLEd-HE and BTLEd-IA students. Before the intervention, almost all students scored below the passing level despite moderate confidence; after two cycles of the interactive Genially tutorial, most students passed, the gain was statistically significant with a large effect size, and students reported greater confidence and positive perceptions of the tutorial's usefulness and usability. The action research cycle allowed technical and accessibility problems to be identified and corrected between cycles. Eleven students did not reach the passing level, and confidence did not reflect actual performance, which shows the need for targeted support and self-assessment practice.

5.1 Sustainability and Action Plan

To sustain the intervention, PAGTUKLAS will be integrated into regular Technology Research 1 class activities every semester, with structured guidance and updated content. Pre-recorded video tutorials, digital copies and QR codes will keep the materials accessible, and the content will be reviewed each semester using feedback from students and teachers. Teachers will be trained to facilitate the tutorial and a coordinator will be assigned, technical support and troubleshooting guidelines will be set up with ICT staff, and the researchers will work with administrators to include PAGTUKLAS in official lesson plans and assessment practices. To reduce risks, absent or late students will complete the activities asynchronously with monitored outputs and reminders through the class group chat, and identical answers will not be accepted, because the tutorial records each student's submission.

5.2 Reflection and Recommendations

The implementation showed that a flexible, guided learning approach can support students with different needs, including those affected by peer reliance, tardiness, absenteeism and unstable connections. Interviews and observation notes were essential for refining the tutorial, and the revised version made it easier for students to express complete answers and allowed the researchers to monitor participation in real time. It is recommended that teachers continue to use PAGTUKLAS in Technology Research courses, provide catch-up sessions and individual feedback for students who do not reach the passing level, and include calibration activities that help students compare their confidence with their actual performance. Future studies should use a comparison group, a parallel form of the test with a different invention abstract, inter-rater scoring of the tests and a follow-up assessment of retention.

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