# 21st Century Learning and Innovation Skills of Students in Relation to Research Competence

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## ABSTRACT

This study, entitled 21st Century Learning and Innovation Skills of Students in Relation to Research Competence, examined the relationship between modern cognitive skills and academic inquiry among Grade 12 Senior High School students in a public school in Negros Occidental during the academic year 2025–2026. Utilizing a descriptive-correlational research design, the investigation analyzed students' demographic profiles age, sex, and strand alongside their proficiency in critical thinking and problem solving, communication and collaboration, and information and media literacy. Research competence was assessed through indicators such as problem formulation and literature review, methodology and data collection, data analysis and technical interpretation, and research ethics and dissemination. Findings revealed that students exhibited strong communication and collaboration skills, while critical thinking and information literacy were comparatively weaker. Results further indicated a significant relationship between 21st-century learning and innovation skills and research competence, suggesting that the enhancement of these skills contributes to improved research performance. The study underscores the importance of integrating 21st-century learning competencies into academic programs to strengthen students' capacity for inquiry and knowledge creation. The scope of the research was limited to Grade 12 students in one public school, thereby restricting the generalizability of findings to broader contexts. Nonetheless, the study provides valuable insights into the interplay between cognitive skills and research competence, offering implications for curriculum development, instructional strategies, and educational policy aimed at preparing learners for the demands of higher education and professional practice in the 21st century.

**Keywords:** 21st-century learning skills, Innovation skills, Research competence, Critical thinking, Problem solving, Communication and collaboration, Information and media literacy, Senior High School students, Descriptive-correlational design

## INTRODUCTION

In today's technology-driven world, rote learning is insufficient, prompting a global shift toward 21st-century competencies (Roshid & Haider, 2024). The P21 framework identifies life and career skills, information/media/technology skills, and learning and innovation skills the "4Cs" (Critical Thinking, Communication, Collaboration, Creativity) as foundational for higher-order cognitive development (Diquito et al., 2022). In the Philippines, the K to 12 Basic Education Program (RA 10533) mandates integration of 21st-century skills to produce globally competitive graduates (Prudente et al., 2024). Research competence—problem identification, data analysis, and conclusion synthesis is treated as a capstone of academic maturity, closely linked to the 4Cs.

However, a gap persists between educational ideals and classroom realities. While local studies show positive links between 21st-century skills and academic success, many Filipino students struggle with literature synthesis, data analysis, and problem formulation (Prudente et al., 2024). Moreover, few empirical studies directly examine

the relationship between learning and innovation skills and research competence in the Philippine context. This study addresses that gap by assessing students' 4Cs in relation to their research competence, offering insights for educators and curriculum designers to better integrate innovation with inquiry.

# METHODOLOGY

This study used a quantitative descriptive-correlational design to examine the relationship between students' 21st-century learning and innovation skills and research competence, with a causal-comparative component for profile differences. Respondents were Grade 12 students from STEM, HUMSS, ABM, and TVL strands in a public school in Negros Occidental (AY 2025–2026). From a population of 362, a sample of 190 was determined using Yamane's formula at 5% margin of error. Stratified random sampling ensured proportional representation, and surveys were distributed digitally via Google Forms with a 100% response rate.

The instrument, adapted from Hassan et al. (2020), included 12 items on the "4Cs" (critical thinking, communication, collaboration, creativity) and 16 items on research competence (problem formulation, methodology, data analysis, ethics, dissemination), rated on a five-point Likert scale. Validity indices were 4.23 and 4.44, and reliability indices 0.76 and 0.84, confirming strong psychometric properties.

Data collection followed formal permissions and orientations, ensuring confidentiality. For analysis, frequency and percentage described profiles, weighted mean and standard deviation assessed skills and competence, Kruskal-Wallis tested differences across profiles, and Spearman's rho examined relationships between skills and competence.

# RESULTS AND DISCUSSIONS

### Profile of the Respondents

Table 1. Frequency and Percent Distribution of the Students according to Profile.

| Profile | Category | f | % |
|---|---|---|---|
| Age | | | |
| | 16 years old | 43 | 22.63 |
| | 17 years old | 105 | 55.26 |
| | 18 years old | 37 | 19.47 |
| | 19 years old | 5 | 2.63 |
| | Total | 190 | 100.00 |
| Sex | | | |
| | Male | 79 | 41.58 |
| | Female | 111 | 58.42 |
| | Total | 190 | 100.00 |
| Strand | | | |
| | STEM | 28 | 14.74 |
| | HUMSS | 93 | 48.95 |

| | | | |
|---|---|---|---|
| | ABM | 26 | 13.68 |
| | TVL | 43 | 22.63 |
| | Total | 190 | 100.00 |

The demographic profile shows clear patterns in age, sex, and strand. Most students were 17 years old (55.26%), with only 2.63% aged 19, reflecting timely progression through Senior High School. Females comprised the majority at 58.42%, compared to 41.58% males, indicating a gender imbalance that contrasts with the nearly equal male-female ratios reported in the NDHS 2022.

Strand distribution revealed significant disparities the HUMSS strand dominated with 48.95% of respondents, while ABM had the lowest share at 13.68%. This reflects a strong preference for humanities and social sciences, consistent with Padios et al. (2021), who noted that socioeconomic background often influences strand choice, making HUMSS and TVL more accessible to diverse student groups.

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**Level of 21st Century Learning and Innovation Skills**

Table 2. Level of 21st Century Learning and Innovation Skills of Students as a Whole and in terms of Critical Thinking and Problem Solving, Communication and Collaboration, and Information and Media Literacy.

| Statements | Mean | SD | Interpretation |
|---|---|---|---|
| **Critical Thinking and Problem Solving** | 4.04 | 0.45 | **High** |
| 1. I systematically analyze and break down complex arguments or claims to evaluate their factual validity. | 4.06 | 0.86 | High |
| 2. I look at problems from multiple perspectives before deciding on a definitive path or solution. | 4.28 | 0.73 | Very High |
| 3. I can identify underlying biases, inconsistencies, or logical fallacies in open-ended informational texts. | 3.96 | 0.74 | High |
| 4. I synthesize information from various subject areas to solve practical, real-world issues. | 3.66 | 0.87 | High |
| **Communication and Collaboration** | 4.17 | 0.59 | **High** |
| 1. I clearly express technical ideas and concepts orally and in writing using language tailored to my audience. | 4.10 | 0.89 | High |
| 2. I actively listen to and constructively integrate feedback from peers when working toward a shared milestone. | 4.35 | 0.85 | Very High |

| | | | |
|---|---|---|---|
| 3. I share responsibility willingly and compromise effectively with diverse group members to complete collaborative tasks. | 4.37 | 0.85 | Very High |
| 4. I use digital platforms (like cloud documents or shared project workspaces) to communicate and manage group assignments efficiently. | 3.87 | 1.03 | High |
| **Information and media Literacy** | 4.00 | 0.63 | **High** |
| 1. I cross-reference multiple online databases and sources to verify whether a piece of data or digital news is reliable. | 4.02 | 0.76 | High |
| 2. I efficiently filter out irrelevant or low-quality digital data when using search engines for academic investigations. | 3.87 | 0.98 | High |
| 3. I can differentiate between subjective opinion articles and peer-reviewed, evidence-based research reports. | 3.91 | 0.89 | High |
| 4. I properly cite and attribute digital assets, media graphics, and intellectual property to prevent plagiarism. | 4.18 | 0.89 | High |
| **21ST CENTURY LEARNING AND INNOVATION SKILLS (Overall Mean)** | 4.04 | 0.45 | **High** |

*Legend: (4.21-5.00)-Very High; (3.41-4.20)-High; (2.61-3.40)-Moderate; (1.81-2.60)-Low; (1.00-1.80)-Very Low*

The data show that students demonstrated a generally high level of 21st-century learning and innovation skills (M = 4.04, SD = 0.45). Critical thinking, communication, collaboration, and information literacy mostly scored high, with very high ratings in viewing problems from multiple perspectives (M = 4.28) and sharing responsibility in group tasks (M = 4.37). Low SD values indicate consistent agreement, while higher SDs (e.g., 1.03 for digital collaboration) reveal variability, suggesting some students excel in technology-based teamwork while others struggle.

Supporting this, Cahulugan, Bucar, & Bongato (2024) found that critical thinking, collaboration, and digital literacy enhance academic performance, while Garcia & Villanueva (2022) emphasized collaborative environments strengthen communication and teamwork.

Contradicting these results, Scoular (2021) argued that students often show only moderate proficiency, particularly in synthesizing information across disciplines. Similarly, Tan & Chua (2023) reported Southeast Asian students struggled with advanced information literacy tasks, aligning with the relatively lower mean scores in this domain.

**Research Competence of Students**

Table 3. Level of the Research Competence of Students as a Whole and in Terms of Problem Formulation and Literature Review, Methodology and Data Collection, Data Analysis and Technical Interpretation, and Research Ethics and Dissemination.

| Statements | Mean | SD | Interpretation |
|---|---|---|---|
| **Problem Formulation and Literature Review** | 3.83 | 0.51 | **High** |
| 1. I can narrow down a broad educational or real-world problem into a clear, researchable question. | 3.84 | 0.78 | High |

| | | | |
|---|---|---|---|
| 2. I can draft a cohesive, structured review of related literature (RRL) using relevant academic journals, books, and public records. | 3.65 | 0.88 | High |
| 3. I can identify evident research gaps in existing studies to justify why my own study is necessary. | 3.93 | 0.77 | High |
| 4. I map out clear conceptual or theoretical frameworks that logically explain the relationships between my study variables. | 3.89 | 0.84 | High |
| **Methodology and Data Collection** | 3.82 | 0.57 | **High** |
| 1. I can choose and justify the correct research design (quantitative, qualitative, or mixed-methods) to answer my research questions. | 3.97 | 0.76 | High |
| 2. I can design or adapt reliable data collection instruments, such as structured interview guides or standardized questionnaires. | 3.96 | 0.83 | High |
| 3. I apply systematic sampling techniques to select a representative group of respondents for a target population. | 3.77 | 0.80 | High |
| 4. I systematically organize and clean raw field data to prepare it for statistical processing or qualitative coding. | 3.61 | 0.69 | High |
| **Data Analysis and Technical Interpretation** | 3.88 | 0.47 | **High** |
| 1. I use appropriate statistical formulas or software to calculate data metrics like standard deviations, percentages, or correlation coefficients (r). | 3.73 | 0.83 | High |
| 2. I code and thematic-map qualitative interview transcripts to extract meaningful, objective themes. | 3.81 | 0.90 | High |
| 3. I interpret statistical tables or thematic matrices accurately, drawing conclusions that directly address the main research questions. | 3.96 | 0.69 | High |
| 4. I discuss my data findings by directly comparing them to the historical literature and empirical studies cited in my review. | 4.04 | 0.82 | High |
| **Research Ethics and Dissemination** | 4.17 | 0.61 | **High** |
| 1. I strictly preserve participant anonymity and secure informed consent before conducting any data gathering or interviews. | 4.18 | 0.82 | High |
| 2. I report all research findings accurately and transparently, even if the data contradict my initial expectations or hypotheses. | 4.16 | 0.89 | High |
| 3. I format all in-text citations and reference list entries perfectly using standard academic style manuals (such as APA, MLA, or Chicago style). | 4.06 | 0.73 | High |
| 4. I present research conclusions clearly through oral research defense panels, action research updates, or scholarly writeups. | 4.28 | 0.71 | High |
| **RESEARCH COMPETENCE (Overall Mean)** | 3.93 | 0.43 | **High** |

*Legend: (4.21-5.00)-Very High; (3.41-4.20)-High; (2.61-3.40)-Moderate; (1.81-2.60)-Low; (1.00-1.80)-Very Low*

The results show that students possess a high level of research competence overall (M = 3.93, SD = 0.43), with strongest performance in research ethics and dissemination (M = 4.17). This suggests confidence in conducting research responsibly and presenting findings effectively. Lower scores in literature review (M = 3.65) and data organization (M = 3.61) indicate areas needing improvement, while higher SDs in tasks like qualitative coding (SD = 0.90) reveal variability, highlighting the need for differentiated support.

Supporting this, Molina (2021) found Filipino STEM students excelled in ethics and conceptual frameworks but struggled with technical aspects. Marushkevych et al. (2022) emphasized that structured training programs enhance competence, reinforcing the importance of institutional guidance.

Contradicting these results, Ciraso-Calí et al. (2022) reported uneven acquisition of research competence among Spanish undergraduates, particularly in literature review and data analysis. This suggests that while competence can be high in certain contexts, institutional and curricular differences strongly influence outcomes.

**21st Century Learning and Innovation Skills and Age**

Table 4. Difference in the 21st Learning and Innovation Skills when grouped according to Age.

| Age | Test Statistics (H) | p-value | Decision for $H_o$ | Interpretation |
|---|---|---|---|---|
| 16 years old | 2.702 | 0.440 | Failed to Reject $H_o$ | Not Significant |
| 17 years old | | | | |
| 18 years old | | | | |
| 19 years old | | | | |

The statistical analysis shows that for age, the computed test statistic (H = 2.702) with a p-value of 0.440 leads to the decision to fail to reject the null hypothesis. This indicates no significant difference in 21st-century learning and innovation skills when grouped by age, meaning age is not a determining factor. The high p-value suggests observed differences are due to chance rather than systematic effects.

Supporting this, Care and Luo (2021) concluded that the acquisition of 21st-century skills is shaped more by instructional design and learning environments than by demographic variables. Similarly, Almarghani and Mijatovic (2021) found that teaching methods, particularly active and collaborative approaches, strongly influence skill development, with no evidence of age-related differences.

Contrary perspectives exist, Hanushek et al. (2025) reported that cognitive skills such as literacy and numeracy decline with age, potentially affecting problem-solving and innovation. Likewise, Kirchhoff and Keller (2021) emphasized age-specific trajectories in life skills, noting adolescents often show stronger collaborative and socio-cultural capacities. These findings suggest age may play a role in certain aspects of skill acquisition, challenging the notion that it is irrelevant.

**21st Century Learning and Innovation Skills and Sex**

Table 5. Difference in the 21st Learning and Innovation Skills when grouped according to Sex.

| Sex | Test Statistics (U) | p-value | Decision for $H_o$ | Interpretation |
|---|---|---|---|---|
| Male | 3902.000 | 0.195 | Failed to Reject $H_o$ | Not Significant |
| Female | | | | |

The statistical analysis shows that the computed test statistic (U = 3902.000) with a p-value of .195 is greater than 0.05, leading to the decision to fail to reject the null hypothesis. This indicates no significant difference in 21st-century learning and innovation skills between male and female students, meaning both groups demonstrate comparable levels of critical thinking, communication, collaboration, and media literacy.

Supporting this, Ferreras-Garcia et al. (2021) found that gender did not significantly determine innovation competence, while Gómez-Trigueros and Yáñez de Aldecoa (2021) noted that although females reported lower perceptions of digital competence, actual performance outcomes were comparable. These studies reinforce that sex is not a decisive factor in skill acquisition.

However, contrasting evidence exists. Camara et al. (2021) reported that female Senior High School students in the Philippines demonstrated higher competence in research writing, while Beroíza-Valenzuela and Salas-Guzmán (2024) highlighted persistent gender gaps in STEM education, with women underrepresented in innovation contexts. These findings suggest that while sex may not affect general 21st-century skills, it can influence specific research-related competencies.

**21st Century Learning and Innovation Skills and Strand**

Table 6. Difference in the 21st Learning and Innovation Skills when grouped according to Strand

| Strand | Test Statistics (H) | p-value | Decision for $H_o$ | Interpretation |
|---|---|---|---|---|
| STEM | 2.914 | 0.405 | Failed to Reject $H_o$ | Not Significant |
| HUMSS | | | | |
| ABM | | | | |
| TVL | | | | |

The results in Table 6 show that the computed test statistic (H = 2.914) with a p-value of .405 is greater than 0.05, leading to the decision to fail to reject the null hypothesis. This indicates no significant difference in 21st-century learning and innovation skills across strands (STEM, HUMSS, ABM, TVL). Students therefore demonstrate comparable levels of critical thinking, communication, collaboration, and media literacy regardless of strand.

Supporting this, Pangilinan et al. (2026) found that 21st-century skills are transversal across the K to 12 curriculum, intentionally integrated across disciplines. Similarly, Scoular (2020), cited in Serafico-Reyes et al. (2022), concluded that skills are embedded across strands, with teaching strategies and curriculum alignment playing a greater role than strand specialization.

Contradicting this, Bustos and Marabe (2016) noted unequal opportunities to practice innovation and collaboration due to strand-specific emphases, with STEM students more exposed to problem-solving and HUMSS students to communication. Scoular also observed variation in implementation, with STEM strands showing stronger alignment to critical thinking compared to TVL. These findings suggest that while strand may not determine overall skill acquisition, differences in emphasis and teaching approaches can shape the depth of 21st-century skill development.

**Research Competence and Age**

Table 7. Difference in the Research Competence when grouped according to Age.

| Age | Test Statistics (H) | p-value | Decision for $H_o$ | Interpretation |
|---|---|---|---|---|
| 16 years old | 1.392 | 0.707 | Failed to | Not Significant |

| | | | | |
|---|---|---|---|---|
| 17 years old | | | Reject $H_o$ | |
| 18 years old | | | | |
| 19 years old | | | | |

The results in Table 7 show that the computed test statistic (H = 1.392) with a p-value of .707 is greater than 0.05, leading to the decision to fail to reject the null hypothesis. This indicates no significant difference in research competence across age groups (16–19), meaning students demonstrate comparable levels of problem formulation, methodology, data analysis, and research ethics regardless of age.

Supporting this, Grande et al. (2021) found that while age and performance can predict competence, differences among students within close age ranges were not statistically significant, with competence more strongly linked to grades and structured learning outcomes. Similarly, Urruticoechea et al. (2021) concluded that age within narrow adolescent ranges does not significantly affect academic competencies, emphasizing the role of educational practices.

Contrary evidence suggests age may matter. Bocar (2021) reported that older students show stronger analytical reasoning and adaptability, while Alvarez and Ramos (2022) found variations in research skill acquisition linked to experiential learning. Mendoza et al. (2023) confirmed older cohorts exhibit higher proficiency in scientific writing and methodology, and Garcia and Cruz (2024) observed fewer cognitive and procedural difficulties among older students. These findings highlight that while age may not significantly affect competence within narrow ranges, developmental maturity can influence research readiness and performance.

**Research Competence and Sex**

Table 8. Difference in the Research Competence when grouped according to Sex.

| Sex | Test Statistics (U) | p-value | Decision for $H_o$ | Interpretation |
|---|---|---|---|---|
| Male | 3920.000 | 0.210 | Failed to | Not Significant |
| Female | | | Reject $H_o$ | |

The results in Table 8 show that the computed test statistic (U = 3920.000) with a p-value of .210 is greater than 0.05, leading to the decision to fail to reject the null hypothesis. This indicates no significant difference in research competence between male and female students, meaning both groups demonstrate comparable levels of problem formulation, methodology, data analysis, and research ethics.

Supporting this, Grande et al. (2021) found that male and female nursing students in the Philippines showed similar competence, with performance shaped more by structured research courses than sex differences. Likewise, Dela Cruz and Lapitan (2022) reported that gender was not a significant predictor of research skills, emphasizing the role of curriculum design and mentoring.

Contrary evidence suggests gender may influence competence. Bocar and Aseron (2021) found female students more proficient in academic writing and literature synthesis, while Santos and De Vera (2022) observed female superiority in data analysis and methodological application due to stronger metacognitive regulation. Similarly, Chen et al. (2023) reported higher self-efficacy among female researchers, and Ocampo and Morales (2024) confirmed females consistently outscore males in qualitative analysis and report drafting. These findings suggest that while sex may not affect general competence, it can influence specific dimensions of research performance.

**Research Competence and Strand**

Table 9. Difference in the Research Competence when grouped according to Strand.

| Strand | Test Statistics (H) | p-value | Decision for $H_o$ | Interpretation |
|---|---|---|---|---|
| STEM | 0.239 | 0.971 | Failed to Reject $H_o$ | Not Significant |
| HUMSS | | | | |
| ABM | | | | |
| TVL | | | | |

The results in Table 9 show that the computed test statistic (H = 0.239) with a p-value of .971 is greater than 0.05, leading to the decision to fail to reject the null hypothesis. This indicates no significant difference in research competence across strands (STEM, HUMSS, ABM, TVL), meaning students demonstrate comparable levels of problem formulation, methodology, data analysis, and research ethics regardless of strand.

Supporting this, Serafico-Reyes, Barba, & Gomez (2022) found that research-related competencies are embedded across strands in the Philippine ALS curriculum, while Pangilinan et al. (2026) emphasized that research skills are transversal in the K to 12 curriculum, shaped more by instructional strategies than strand specialization.

Contrary evidence suggests strand may influence competence. Dela Cruz & Santos (2022) reported disparities, with STEM and HUMSS students showing stronger methodological application than TVL peers. Aguilar et al. (2023) highlighted distinct cognitive skill sets across strands, while Ramos & Villanueva (2024) noted specialized strands undergo more intensive research coursework. Similarly, Mendoza & Garcia (2025) confirmed strand classification predicts research output quality. These findings suggest that while strands may not determine overall competence, curricular focus and exposure can shape specific research skills.

**21st Century Learning and Innovation Skills and Research Competence**

Table 10. Relationship Between 21st Century Learning and Innovation Skills and Research Competence of Students.

| Variable | Test Statistics ($r_s$) | p-value | Decision for $H_o$ | Interpretation |
|---|---|---|---|---|
| 21st Century Learning And Innovation Skills vs. | 0.613 | <0.001 | Reject $H_o$ | Significant |
| Research Competence | | | | |

The results in Table 10 show a Spearman's rank correlation coefficient of 0.613 with a p-value < .001, leading to the rejection of the null hypothesis. This indicates a significant relationship between students' 21st-century learning and innovation skills and their research competence. In other words, higher levels of creativity, critical thinking, collaboration, and communication correspond to stronger research proficiency.

Supporting this, Ocampo (2021) found that 21st-century competencies of pre-service educators directly correlate with pedagogical and academic performance, confirming that innovation-centric skills elevate research execution. Conversely, Mutohhari et al. (2021) noted challenges in technical-vocational contexts, where deficiencies in communication and collaboration hinder the direct translation of these skills into research competence. These findings highlight both the strength of the relationship and the practical barriers that may weaken it in certain educational settings.

## CONCLUSION

The demographic profile of the respondents reveals that most are in the later years of adolescence, predominantly female, and largely enrolled in the HUMSS strand. This distribution indicates that younger learners from

HUMSS constitute the largest proportion of the sample, which shapes the overall trends observed in their academic skills and competencies.

The findings show that students consistently demonstrate a high level of 21st century learning and innovation skills, particularly in communication and collaboration, critical thinking, and information literacy. Their ability to examine problems from multiple perspectives, share responsibilities effectively, and properly cite sources underscores their preparedness for the demands of contemporary academic and professional contexts.

Students likewise exhibit a high level of research competence across all dimensions, with research ethics and dissemination emerging as the strongest areas. Their capacity to identify research gaps, select appropriate methodologies, analyze data, and uphold ethical standards reflects their readiness to engage in rigorous scholarly inquiry and contribute meaningfully to the advancement of knowledge.

The significant difference between 21st century learning and innovation skills and students' profile do not significantly influence their 21st-century learning and innovation skills, implying that these competencies are developed uniformly across student cohorts regardless of age, sex, or chosen track.

There significant difference between research competence and students' profile is independent. This implies that age, sex, and academic track do not dictate research capabilities, indicating a uniform baseline level of research skills across student groups.

The significant relationship between 21st century learning and innovation skills and research competence confirms that these domains are interdependent. The correlation suggests that the enhancement of students' innovation and learning skills directly strengthens their research competence, thereby reinforcing the importance of holistic skill development in preparing learners for both academic excellence and professional success.

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