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Research Article

Bridging Research Competencies and Outcomes: Technological Skills Leading The 21st-Century Research Era

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ABSTRACT

With the researcher's assumption that a specific research skill may positively contribute to the learners' research output, a 240-item standardized test question was conducted among the 231 grade 12 students. The questionnaires are fitted according to the DepEd self-learning modules from the senior high school curriculum. This study developed a model to examine the relationship between the grade 12 students' research skills and their research output. Statistical analysis revealed that learners scored low in *Data Analysis*, *Critical Thinking*, and *Interpreting Result*, with mean scores of 47.4, 44.9, and 43.6, respectively. Ran through *Jamovi* version 2.3.28 software, the correlation matrix revealed that six of the eight identified research skills statistically significant to the research output were used for confirmatory factor analysis. Two research skills used for the mediation model stood out from the rest. The *Information & Literacy* skills were better suited to mediate *Technological skills* and research output compared to *Technological* skills alone. The model demonstrated a strong relationship between the independent variable-*Technological* skills, and the dependent variable- their ability to conduct effective research.

Keywords: *Research Skills, Practical Research, Senior High School Curriculum, Mediation Analysis, Structural Equation Modeling*

Introduction

Students and teachers view Practical Research as a personally rewarding course yet difficult to comprehend. Because of its intricacies, such as finding problems to address, careful consideration of the research design, appropriate instruments to gather data, statistical tools to use, and analysis and discussion of results, the goal of achieving a well-crafted research output can be mentally deteriorating. Research teachers assume that, with their strong academic connections to other senior high school subjects, students will produce quality research outputs.

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Introducing practical research proved to be unexpectedly difficult for the new teachers assigned to teach the subject. Over seven years, Practical Research was tagged by many senior high school students and teachers as one of the most daunting yet exhausting courses to face. According to Siguaan & Ecija (2020), research is a challenging course to deal with, slightly misunderstood by students who dislike it. The course is believed to be the foundation of what they should expect in higher education courses. Handling practical research is challenging for teachers and much more so for learning. Still, it provides an avenue for exploration, say Lucas et al. (2021).

The researcher has experienced that senior high school students show good analysis skills but fail to compose effective essays, which is a basic skill in crafting research work. Some students who excel in paraphrasing could not demonstrate compounding paragraphs. Other students excel in mathematical computation, especially when dealing with symbols. Still, they fail to translate the findings of the results into words. Some students are highly literate with computers but could not find relevant articles to incorporate. These students' failure in a few research skills only reveals that they could not demonstrate research competency seamlessly, regardless of their academic performance. For instance, a two-part questionnaire was given to 963 graduating students in the study by Arellano et al. (2012), as cited in Saunders & Jamieson (2020), to determine how proficient they handled research. This demonstrated that although some goals of the research process were met, fewer than 50% of the participants felt competent in handling hypothesis testing, creating suitable scales, and choosing the correct statistical analysis for the project. Their performance in describing the general procedures involved in solving a research problem was also subpar.

This study aims to determine what competencies in senior high school subjects make students excel in their research work. Further, the study seeks to measure the degree of understanding among the grade 12 students regarding their research competencies or skills that exist in the current senior high school curriculum. These skills are found in the existing core subjects of the senior high school curriculum and are introduced and applied in the succeeding practical research subjects. Through this, the researcher seeks answers about the significant relationship of these research competencies to the grades of their research outputs.

As for research, the following competencies or skills, with their respective senior high school equivalents, shall be prepared by the investigator to help clarify this phenomenon: *Basic Writing Skills* (Reading and Writing), *Data Analysis Skills* (Statistics and Probability), *Critical Thinking Skills* (English for Academic and Professional Purposes), *Interpreting Result Skills* (English for Academic and Professional Purposes), *Effective Communication Skills* (Oral Communications in Context), *Information and Literacy Skills* (Media & Information Literacy), *Technological Skills* (Empowerment Technologies), and *Collaboration and Teamwork Skills* (Personality Development). The test shall be based on the competencies of each research skill mirrored in the Most Essential Learning Competencies (MELC) of DepEd.

From the identified independent variables, such as the research skills, the investigator correlates these with the independent variable, the research output. The correlation of these variables will help identify which of the independent variables has significantly influenced the dependent variable. From the result, a model will be generated based on the underlying assumption of the researcher that research students demonstrate exceptional research skills if they perform well in other senior high school subjects.

Under the basic education curriculum, developing research competencies among senior high school students has become a main concern. With the introduction of the senior high school curriculum in the Philippines, students are exposed to various academic challenges, and one of the most demanding courses they encounter is the Practical Research subjects. These courses posed a significant challenge for both students and teachers, leaving many perplexed by their complexities. Amidst this complicated educational framework, a fundamental question emerges: how can students excel in research work?

Theoretical Framework

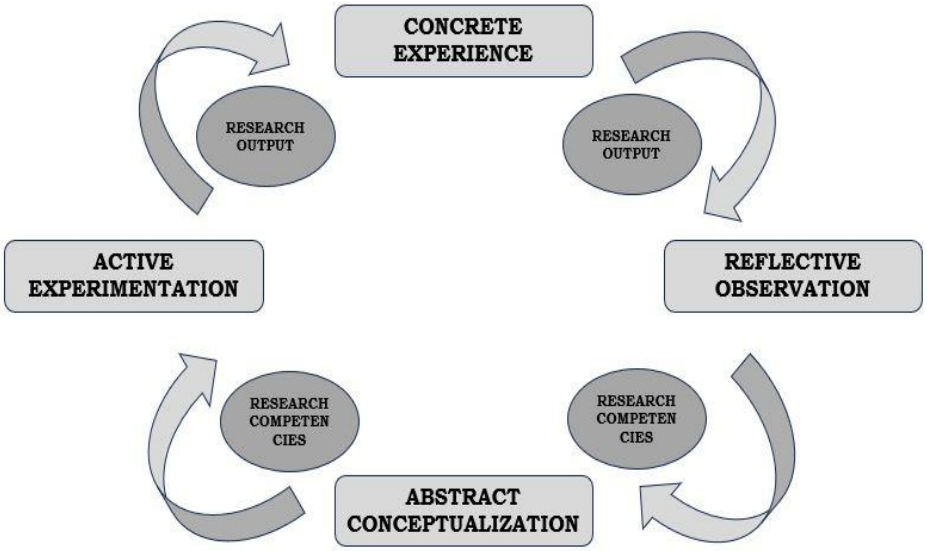

Figure 1. Theoretical Framework using Kolb's Experiential Learning Theory

This study embraces Kolb's Experiential Learning Theory as its theoretical framework. According to Kolb, learning entails gaining abstract concepts that are adaptable and applicable in a variety of contexts. Further, Kolb's theory clarifies that novel experiences catalyze the creation of new concepts (Macleod, 2023). The theory posits that learning is a continuous, cyclical process involving four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Through this theoretical grounding, this study explores how Kolb's theory is applied within the senior high school research competencies and curriculum.

Conceptual Diagram of a Model

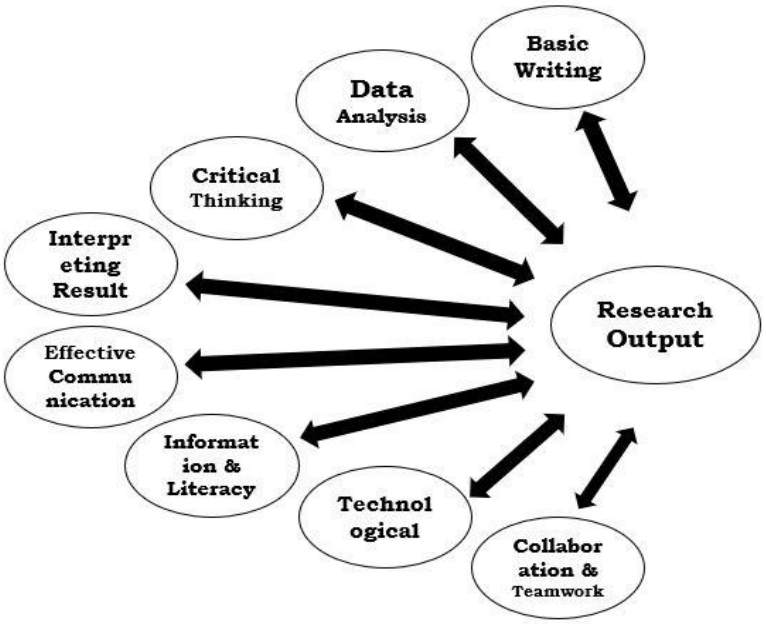

Figure 2. Conceptual Diagram of a Model

The conceptual framework for investigating the association between research abilities and research output comprises eight key research skills. These skills are the independent factors that are expected to positively influence the dependent variable, which is the research output, as assessed by grade or research quality. Each skill is intended to improve research performance, implying that competency in these areas leads to higher-quality research results. Arrows connecting each research skill to the research result represent the relationships between these variables, demonstrating a positive correlation. The diagram offers a structured strategy for determining how various research competencies affect overall success.

Statement of Purpose

The primary objective of the research is to craft a model by correlating the research skills and the research output of grade 12 students in the district of Pilar for the school year 2023-2024. Specifically, it will answer the following questions:

1. What are the research skills of the Senior High School in terms of:
   1.1. Basic writing skills
   1.2. Data analysis skills
   1.3. Critical thinking skills
   1.4. Interpreting results skills
   1.5. Effective communication skills
   1.6. Information and Literacy skills
   1.7. Technological skills
   1.8. Collaboration and teamwork skills
2. What are the grades of the students' research output?
3. Is there a significant correlation between the students' research skills and research output?
4. Which of the research skills can predict the research output?
5. Is technological skills a mediator between the relationship between the research output and research skills?
6. Based on the study's results, what model can be developed?

Null Hypotheses

Ho1: There is no significant relationship exists between senior high school students' research skills or competencies and research outputs.

Ho2: Students who excel in the following research competencies do not yield higher-quality research outputs.

Ho3: Technological skills do not mediate a research skill and a research output.

Review of Related Literature and Studies

The research curriculum in senior high school draws the researcher's curiosity to understand its densities and possible connections with other senior high school subjects. The researcher, who happens to be a product of the Department of Education Culture and Sports and Basic Education Curriculum, understood the deficiency of knowledge in several areas back in the day. The newness of the subject, as introduced in senior high school, is the grounding of breakthroughs. Students are exposed to cutting-edge concepts and information that can provide a strong basis for future innovations.

The Research Curriculum in Senior High School

There is often misunderstanding about the subject Practical Research in the teaching profession. Concerns about the ability of teachers to teach the course in a reasonable manner prevent it. Caraig (2022) asserts that practical research is not a specialization, particularly in high school. Teachers are given subjects that are misleading or mismatched because they are still learning about them. This mismatch can cause a variety of issues, from struggling to convey content to feeling overwhelmed and underprepared (Kabilan & Izzaham, 2008) effectively.

Additionally, teachers handling the subjects do not have proper training or have not attended seminars related to research. Many teachers are also not inclined to study the subject since they have no experience. They are hesitant to pursue further education or training, frequently due to a lack of personal experience with the subject (Yoon, 2002). Sicat (in press) say it can be particularly difficult to articulate basic concepts and elements of research when teaching subjects outside their area of expertise. The loading of subjects is given to teachers with solid background experience.

This study on the connection between students' research competency and research output not only highlights students' abilities in research but will also provide a clearer understanding of the role of a research teacher. Research Competencies Framework (2007), as cited in Saunders and Jamieson (2020), explained that the skills outlined for dentists are needed to certify a technically competent researcher. These skills fall into five categories: problem-solving and practical application of skills; communication and critical thinking skills; professional and personal attitudes and ethics; sharing of findings; and taking on the role of the researcher.

The Most Essential Learning Competencies

The Philippines was one of only three nations in the world (along with Angola and Djibouti) and the only nation in Southeast Asia to maintain a ten-year pre-university education cycle before the program's implementation in 2013. According to Brillantes et al. (2019), there has been a challenge for both students and teachers in the Philippines to meet global standards when cramming the 12-year global education curriculum into a 10-year program. The old basic education curriculum of the Philippines remains the lousiest in worldwide education and hinders its competition among other developing nations.

Sarmiento & Orale (2016), cited in Sales (2023), state that the SHS curriculum aims to prepare students for college admission or industry employment. The SHS program, the last stage of basic education programs, follows a more structured model with ten strands and a minimum of four tracks (academics, tech-voc, sports, and arts & design). On the other hand, Joel Tabora's article stated that the senior high school curriculum is overly packed and that the subjects offered for the various tracks should be reevaluated to ensure that the graduates have the necessary skills to meet the demands of the workforce. If this situation is not adequately addressed, the primary goal of a job-ready individual might not be achieved after graduation, which suggests that the system is ineffective based on what is expected (Cogal, 2019). Teachers need to adapt, adjust, and contextualize their teaching methods in light of the new curriculum that DepEd has introduced to meet the needs of today's students, who have a variety of learning preferences. As students acquire 21st-century skills and competencies, the teaching and learning becomes more complex (Aranda, 2022).

Resoor (2023) proposed that Senior High School (SHS) teachers be encouraged to pursue graduate and post-graduate studies to reskill and upskill their professional and academic competencies with the latest trends in global education to enhance their competence in their field of specialization. This is in light of the challenges that the new educational landscape presents. Additionally, they are urged to apply creativity and ingenuity when utilizing locally accessible teaching resources that profoundly affect instruction delivery.

The Department of Education crafted the Most Essential Learning Competencies (MELCs) to reduce the amount of work teachers must do when deciding what to teach. MELCS stands for knowledge, understanding, skills, and attitudes that students must exhibit in each lesson and/or learning activity, according to Llego (2022). Competencies are essential to acquiring a successful life in the long run and building practical and lifetime skills for learning in times of crisis (pandemic, epidemic, etc.).

Learning competencies are significant because they offer a precise and quantifiable framework for analyzing and assessing an individual's knowledge, skills, and abilities in a given subject or field. They offer direction for curriculum development, foster lifelong learning, and offer clarity. Employers, educators, and students must have these tools (Most Essential Learning Competencies (MELCS, SY 2023–2024, 2023). According to Llego (2022), "essential learning competencies" refers to the knowledge, skills, and abilities students must acquire during the teaching-learning process to improve their readiness for later grade levels and, eventually, lifelong learning. Conversely, desirable learning competencies were described as those that could improve education but might not be required to develop fundamental skills.

SKILL: Basic Writing; SUBJECT: Reading and Writing

In doing research, one essential skill that students need to enhance is their writing ability along with their reading skills. Strong writing abilities are essential for students' success because they allow them to successfully communicate their ideas, research findings, and critical analysis clearly and structured (Vacalares et al., 2023). These two skills are siblings and relevant to developing valuable research work. To compose a sound essay, a researcher should consider reading an article pertinent to the study they are engaging in.

Curriculum for reading and writing, as well as instructional exercises and practices in the classroom, follow strict linguistic guidelines and are pretentious in the educational process (Jaca et al. 2019). Atanacio-Blas et al., 2018; Farkas & Jang, 2019;Graham, Harris, & Beard, 2019; Gustilo & Magno, 2015; Gustilo, 2013; Hall, 2012; Nueva, 2016; Nusrat, 2016; Sadeghi, 2007; Tenri Ampa & Quraisy, 2017 as cited in Urbano et al. (2021), that beyond the Reading and Writing curriculum, students have demonstrated difficulty with reading and writing proficiency because these skills are difficult for ESL/ESL learners to acquire because they are complex.

Academic Reading and Writing for Senior High is a compass that makes it easy for students to read and write in the real world. Writing is an essential skill for students, as it serves as an important tool for effective communication and knowledge dissemination, particularly in composing research-based academic outputs Vacalares et a l., 2023; Parwati & Sugesti, 2023; Khalid & Yamat, 2022; Besral et al., 2020. Every lesson adheres to a modern framework created to enhance students' academic reading and writing abilities and 21st-century skills. Additionally, each chapter's lessons lay the groundwork for reading and writing academic and professional texts. They are filled with numerous examples of texts from different disciplines to give students a more all-encompassing learning experience (Barrot, 2016).

SKILL: Data Analysis; SUBJECT: Statistics and Probability

While statistics analyzes the frequency of past events, probability is used to predict the likelihood of future events. Businesses place their bets on probability and statistics to determine which product will be the most profitable and useful (A Guide to Probability and Statistics for Data Science, n.d.).

Senior high school students must strengthen their data analysis skills, especially in grade 11 Statistics and Probability. Students will learn how to perform quantitative research, which is vital in many academic and professional domains (Trimurtini et al., 2020). Statistics is used in data collection, presentation, and analysis, as well as in problem-solving, product and process design, and decision-making.

Kelley (2023) explains that the process of examining, purifying, converting, and analyzing data to get important insights, make judgments, and aid in decision-making is known as data analysis. It entails analyzing big data sets and identifying relevant patterns, trends, correlations, and relationships within the data by applying various methodologies and tools. Data analysis is crucial in many fields and industries because it provides important insights that can be used to streamline operations, address issues, and arrive at wise decisions.

It is important to note that a certified statistician must guide the success of analyzing quantitative data. According to a study on students' attitudes toward probability and statistics by de Oliveira et al. (2019), students lack confidence when it comes to solving statistical and probabilistic problems. They note that they are not particularly anxious about probability or statistics. However, they do not feel confident when solving these kinds of problems.

Recent research have shown the need to improve statistics and data science education (Bargagliotti et al., 2020). Proficiency in data analysis allows students to successfully evaluate, present, and extract relevant insights from the information they collect. This is vital for

doing rigorous and influential research (Kurnia et al., 2023). Students must also be able to analyze data to make informed business decisions, draw inferences from data, and build problem-solving techniques.

SKILL: Critical Thinking; SUBJECT: English for Academic and Professional Purposes

Many educators view critical thinking as how things are seriously considered. According to Xu et al. (2023), critical thinking entails the cognitive capacity to understand, analyze, synthesize, reason, and evaluate information and the tendency to use these talents. In dealing with research work, critical thinking is a crucial process in determining, conceptualizing, applying, analyzing, synthesizing, and/or evaluating information. One should utilize their highest level of thinking abilities to manage ideas and organize them intellectually skillfully.

It could be claimed that critical thinking is a personal trait that cannot be taught if it is a matter of "dispositions"; perhaps critical thinkers are born, not created. Nonetheless, it is feasible to explicitly teach essential thinking techniques thanks to Bloom's framework and a plethora of other critical thinking "tools" (Wilson, 2019). Including English for Academic and Professional Purposes in the senior high school program allows learners to develop critical thinking abilities. Critical thinking is widely considered as an essential talent for higher education and beyond Li & Jian, 2020; Petek & Bedir, 2018; Zhou et al., 2014.

With an eye toward the learners' future workplace, the English for Academic and Professional Purposes (EAPP) program recognizes the significance of the learners' communicative needs in an academic setting because they are not currently employed in a setting. It is essential to prepare for such things, especially in terms of language proficiency (Allam, 2016). Applying EAPP to the students' learning helps them manage and organize their research work skillfully.

In general, according to ADA University, which offered the same program, the goal of the EAPP is to equip English language learners with the necessary skills for efficient written and oral communication. This will be achieved through high-quality English language instruction that fosters the development of linguistic, cultural, social, and academic skills, highly contextualized and meaningful classroom practices, collaborative work, and a safe learning environment. The level of instruction, therefore, should be given higher emphasis.

SKILL: Interpreting Results; SUBJECT: English for Academic and Professional Purposes

Say you are finished with the data collection and have them statistically tested. Now, it is time for you to write the findings narratively. Frequently, this skill's goal is to state what you have discovered from the test results and try to compare it by answering the statement of purpose. According to Abbadia (2023), a vital part of the research process is interpretation, which aids in evaluating the significance of findings, connecting them to the body of knowledge, and guiding future directions for investigation.

A comprehensive analysis of research findings can help ensure that the conclusions are valid and reliable and that the field of study is understood in an advanced way. Moreover, data analysis is an important aspect of research because it allows researchers to hypothesize and conclude from their findings (Rosenthal, 1997). Researchers can assist readers in understanding the significance of the findings and the implications for future research by giving a narrative description of how the study was conducted and what the results signify in relation to the research topic.

The previous related literature mentioned data analysis under statistics and probability, and now, Interpret results. According to Seth (2022), the process of identifying patterns and trends in data is called data analysis. Giving the data meaning is the process of data interpretation. It entails elucidating the patterns and trends in the data that were found. Data interpretation is the next step after data analysis.

Therefore, data analysis requires the use of statistical tools to test the data and prove the hypothesis, meanwhile, interpretation of the results entails the use of a narrative statement as to how the study came up to be.

SKILL: Effective Communication; SUBJECT: Oral Communication in Context

Effective communication is the key to clearly presenting the research work among the academic community. It is still a research skill because part of proving the integrity of your findings is defending them to academicians and researchers. On the other hand, effective written communication is also vital in producing and developing a research paper. Various abilities are necessary for effective communication, such as communicating nonverbally, listening intently, handling stress when it arises, and identifying and comprehending your and the other person's emotions (Rana, 2015).

Al-Alawneh et al. (2019) noted that these abilities are necessary for all human behavior. Some people can communicate from birth, but it takes more work to make it possible for others. Students in higher education institutions frequently focus solely on improving their academic performance and pay little attention to developing their "soft skills."

Furthermore, effective presentation skills are one of the keys to successfully defending a research work. Make sure you speak clearly, maintain eye contact, and use the right gestures when you practice your delivery. A calm, assured manner greatly enhances the ability to communicate your experience level. Use visual aids thoughtfully and sparingly to improve rather than detract from your presentation (10 Components of a Successful Thesis Defence Presentation, n.d.).

Consequently, when a concept or idea is communicated in such a way that the recipient sees it in the same way as the sender does, that is considered perfect communication. No matter how brilliant an idea is, it is worthless unless it is shared and comprehended by others, said Musheke and Phiri (2021).

Oral Communication in Context course discusses ways to communicate effectively in oral and written language. Clarkson (2016) noted that it is impossible to overestimate the significance of efficient communication, whether it be verbal or written. According to polls, effective writing and speaking are highly regarded by business leaders, and studies have demonstrated that communication skills are critical for success in many careers (Cronin & Tong, 1991). Additionally, communication tactics are essential for maintaining student interest and guaranteeing that material is conveyed effectively in the classroom (Varma et al., 2022).

SKILL: Information & Literacy Skills; SUBJECT: Media and Information Literacy

With the advent of advancing technology, finding relevant sources for your study is even more convenient with just a click of the motherboard. The subtle function of the World Wide Web is seamlessly more accessible. However, the information you may get could be superficial. Media and information literacy in senior high school acknowledges the importance of being informed about the true functionality and usage of information on the internet.

According to Bundy (2004) as cited in Ahmad (2017), information literacy is regarded as a fundamental skill for people in the twenty-first century. Technology and advanced information alone cannot keep people up to date if they lack the necessary aptitude and skill to utilize the information gradually. Bacarrisas (2023) stated that it is common for people to need to arrange and retrieve data from multiple sources. Information's suitability for various contexts is determined by its authority, reliability, and currency. People need information literacy skills to access relevant information.

Acquiring Information Literacy Skills offers direction and experience in locating and utilizing reliable sources for a research project. Enhancing information literacy skills can benefit researchers in academia at all levels Carlock (2020). The acquisition of wealthy information literacy skills is crucial in conducting a quality research output. Khorsheed (2021) opined that undergraduates who possess strong information literacy skills are better equipped to navigate the vast array of information sources, critically analyze the credibility and relevance of the content, and embed it effectively into their academic writing. Finally, Soleymani (2014) also commented that undergraduates must be able to recognize when information is needed, and have the ability to locate, evaluate, and use that information effectively.

SKILL: Technological; SUBJECT: Empowerment Technologies

Developing technical skills can considerably improve their research abilities, which are critical to their academic and future job paths. The study conducted by Murshed et al. (2020) regarding the significant role of technology can be understood in five distinct senses: the technological process, which involves creating devices to manipulate matter, energy, and data; technological items, which involve the arrangement of devices, tools, and strategies; technological information, which includes current realities and methods for controlling these processes; technology as a subset of related technical articles and information; and the technological framework, which includes the mechanical process, articles, information, designers, clients, and the world perspective that drives the technological process. It speeds up data gathering and makes analysis possible at a never-before-seen pace, revolutionizing the rate of discovery.

Additionally, technology makes it easier for researchers worldwide to collaborate, removing geographical barriers and encouraging a team effort toward scientific breakthroughs. Utilizing technology could foster social interaction with friends virtually and help develop digital skills necessary for the twenty-first-century workforce (Ramírez et al., 2021). Its ongoing developments push the limits of knowledge and creativity, redefining the potential for research.

Furthermore, the use of technology in teaching and learning can improve student participation, collaboration, and self-confidence, all of which are necessary for good research (Luthfiyyah et al., 2021). However, it is vital to ensure that the use of technology in education fosters critical thinking, meaning-making, and metacognition rather than passive learning (Huerta et al. 2019). Therefore, it is vital to establish a balance between the benefits and potential negatives of using technology in the classroom.

SKILL: Collaboration & Teamwork; SUBJECT: Personal Development

A group of people working together to accomplish a common goal is the basis of both collaboration and teamwork. People who work collaboratively finish a project as a group. In contrast, those who work in a team combine their individual efforts to achieve a goal. This is the main distinction between the two types of work (Understanding the Differences Between Teamwork and Collaboration, 2018). Though this may not be applicable to all individuals doing solo research, collaboration and teamwork skills may apply to those doing group work.

Cheruvelil et al. (2014) opined that good interpersonal skills (social sensitivity and emotional engagement) are essential for high-performing collaborative research teams because they foster positive interactions among team members, which in turn fostering positive research outcomes. When discussing colossal research work, especially scientific research, teamwork and collaboration are far beyond necessary to conduct the study successfully. When teams work together, they can create outcomes greater than the sum of their individual parts, which no single team could have achieved independently (Kadel, 2023).

Moreover, teamwork improves the quality of the research results and encourages dramatic breakthroughs that would not have been achievable with individual, segregated efforts (Medhi et al., 2019). Interestingly, studies have revealed that smaller yet more diverse teams are frequently more likely to generate highly innovative work than larger teams within a single institution (Dong et al., 2018). This emphasizes the importance of collaboration and diversity, which has a strong and positive correlation with the production of scientific innovation.

Finally, Turner & Baker (2020) concluded that finding pertinent causal modalities from several levels of analysis and considering various environmental factors are necessary when tackling complex problems. Multiple research partners are needed for collaborative endeavors as problems become more difficult.

Relation Between Research Skills and Research Output

The results of the study conducted by Bullo et al. (2021) revealed that most of the respondents in their study faced obstacles in conducting research, such as the lack of time, anxieties

in writing and conducting the study, and perceived research as an additional burden, particularly for those without a solid foundation in writing research or formal training and seminars related to research. Although many learners are proficient in using the World Wide Web, they are at risk of harmful usage of this tool, they face significant encounters in accessing high-quality online education and risk falling behind due to the digital divide due to the limited internet access and technological resources available to them (Bailey, 2021).

According to Basu (2020), in the field of education, research is of utmost significance because it acts as a methodical and scientific tool for gaining a deeper understanding of an existing phenomenon, which opens the door to the investigation of existing theories. Although few research teachers wish to revitalize research program in the junior high school level, a study conducted by Arrieta & Marasigan (2021) revealed that junior high school students are less interested with research and find it difficult to accomplish.

Conversely, the study conducted by Imafuku et al. (2015) on students' perception of research found that students began to see research as a dynamic process connected to learning rather than a content-focused activity. Therefore, researcher subjects should be given more emphasis and focus at the senior high school level. By then, at this level, students pay more attention to the intricacies and complexities of research.

President Ferdinand Marcos Jr. believes that an English speaking learner, no doubt, is also good in both Science and Mathematics and the rest of the subjects Chi (2022). Meanwhile, a study by Mappadang et al. (2022) found a significant correlation between academic interest and achievement. These sources lead us to believe that students who excel academically in these subjects are naturally intelligent, but this is undoubtedly not the case for senior high school students.

Cavilla (2017) contributed a thought-provoking insight. They suggested intellectually integrating self-reflection into educational practices, which can guide students towards unlocking their fullest potential across multiple facets of their lives. This recommendation holds weight in light of the observed interplay between academic interest, academic performance, and potentially research interest. The idea provided by Cavilla (2017) regarding the deliberate inclusion of self-reflection in education emphasizes its significance in helping students realize their full potential and still resonates with the conversation on academic and research interests.

However, Almulla (2023) addresses the importance of cooperation, critical thinking, and problem-solving skills, both historically and today. Further, they say incorporating these skills into our daily lives is essential for addressing challenges and succeeding in the modern world. Wright (2022) added that critical thinking is essential for improving students' capacity for academic success. It calls for abilities like unlocking the truth, making bridging pieces of knowledge, interpreting data, clarifying well-informed conclusions, and delivering communications clearly.

Critical thinking is essential for engagement and success in school, Ferlazzo (2021). Teachers must incorporate critical thinking skills into their lesson plans to do this. Mafarja & Zulnaidi (2022) suggest that individuals who possess strong critical thinking skills are likely to have a higher sense of self-efficacy in their academic abilities.

Methodology

Design

This study employed a multivariate approach to examine the congruence between grade 12 students' research competencies and research output. The independent variable measures research skills in the eight identified senior high school subjects. With this design, the researcher examined the relationship between these variables while considering additional variables that could impact the research output. The study was rigorously planned to gather information that enabled the testing of mediation hypotheses. This entailed ensuring that the independent, mediator, and dependent variables were measured at the proper intervals or circumstances to prove causation.

Morevover, multivariate analysis was used because the study involved eight independent

variables (research skills) that could simultaneously influence the dependent variable (research output). Multiple linear regression helped determine the individual and combined effects of these variables. Mediation analysis was applied to explore whether an additional factor influenced the relationship between research skills and research output. Using Jamovi, the researcher examined whether the mediator fully or partially explained this relationship, providing deeper insights into the causal pathway. However, potential confounding variables may also influence both research skills and research output. Identifying and controlling these confounding factors is essential for ensuring the accuracy and validity of the findings.

Locale

The study was conducted at district of Pilar, in the Camotes group of islands, Province of Cebu, Philippines. Four secondary schools, Pilar National High School (PNHS), Don Filomeno M. Torres Memorial National High School (DFMTMNHS), Lanao National High School (LNHS), and Dapdap National High School (DNHS) serve the junior and senior high school students who live in adjacent barangays. PNHS has a total of 105 grade 12 students; DFMTMNHS has a total of 66 grade 12 students; LNHS has a total of 80 grade 12 students; and DNHS has a total of 37 grade 12 students. The Pilar district has a grand total of 288 grade 12 students.

Participant

During the data collection, only 231 grade 12 students participated in the study. These students were expected to be 18 years old and older and bonafide students of any of the four secondary schools of Pilar. The respondents had completed the eight core and applied subjects covered in the test questionnaire.

Instrument

The study used a standardized test questionnaire. These questionnaires were carefully selected by the specialized teachers handling the core and applied subjects mentioned in this study.

Moreover, they were taken from the self-learning modules prepared by the Department of Education; thus, they had not undergone any modifications, reliability, or validity tests because they were already standardized and officially approved for educational use. These test questionnaires had been developed, reviewed, and quality-assured by the Department of Education, ensuring their alignment with the curriculum and learning competencies. Since they had already undergone rigorous scrutiny before implementation, further validation or reliability testing was deemed unnecessary for this study.

The questionnaires representing each research skill were technically varied according to the competencies they cover and the skills they highlight. The questionnaire has eight sets of questions, with 30 items per set.

Data Gathering Procedure

Pre-Data Collection. The researcher navigated through a systematic process of obtaining approval, seeking guidance, and carefully considering feedback from the panelists during the research proposal. Since it had to be consistent with the recorded proceedings before the manuscript was submitted for approval to the Research Ethics Committee (REC) it was essential for the researcher to follow the panelists' recommendations. The REC examined whether the researcher incorporated all the panelists' suggestions appropriately. The REC approved the manuscripts and issued an NTP (Notice to Proceed) certificate.

Actual data collection. After receiving the NTP from the REC, the researcher briefly oriented the subject teacher who handled the practical research subject and the class advisers of grade 12 on the rigor of the data collection process. The test questionnaire had 240 items covering six subjects in the senior high school classes. Therefore, administering the test questions lasted for up to 5 hours. The test administration ran for three days to lessen the students' fatigue and give them time to relax mentally and physically. This undertaking was announced beforehand so that the grade 12 students could prepare.

The researcher advisers from each school administered the tests to the grade 12 students, ensuring that they diligently answered the questionnaires. Alongside collecting these

questionnaires, the researcher ensured that the students' grades for their research outputs were appropriately documented. The researcher asked the research teachers for the grades of the research output of students without indicating their names on a separate sheet.

Post-Data Collection. The test questionnaires' completeness and accuracy were carefully examined. Any discrepancies or gaps in the data filled in to guarantee the accuracy of the information gathered. After verification, the answered questionnaires were checked and recorded. These should be encoded for statistical analysis.

Data integrity and security were crucial. To ensure confidentiality, the gathered questionnaires and grades were converted and kept in a safe database to which only authorized users have access. Most likely, backup systems were put in place to guard against data loss. Safeguarding student information also required maintaining records in compliance with data protection laws and ethical standards. The data was kept privately on the researcher's personal computers for one year or until the manuscript was successfully published and the researcher graduated.

Data Analysis

Pearson R Correlation was the first statistical tool to examine the variables' significance and relationships. On the other hand, multilinear analysis often involves multiple independent variables and a dependent variable, such as multiple linear regression. In this study, the eight independent variables that measured the students' research skills correlated with the dependent variable, the research output.

Before performing the mediation analysis in this study, the eight distinct questionnaires measured the independent variable (research skills). The relationship between research skills and research outputs was examined, and a potential mediator was found and measured. Research outputs, the dependent variable, would then be calculated. The researcher would then be able to comprehend the indirect effects and establish a causal pathway by using advanced statistical software such as Jamovi to analyze whether the mediator explained all or part of the relationship between research skills and research outputs.

Ethical Consideration

The study was conducted according to the guidelines of the Declaration of Helsinki. The Helsinki Declaration outlines moral guidelines for medical research involving human participants, including studies involving identifiable human data and materials. For instance, after administering the test questionnaires to grade 12 participants, the researcher adhered to all ethical guidelines.

I was approved following the Research and Ethics Committee protocol of the University of the Visayas. The research involved students of legal age answering the test questionnaires. Before that, an accompanying cover letter was given to explain the confidentiality and purpose of the study, the potential objectives, and the voluntary participation. No financial incentives were provided to participate in the study. The author declared no conflict of interest.

Results and Discussions

Summary of Scores in the Research Proficiency Exam and Grades in Research Output

Table 1. Summary of Scores and Grades

	BasWr	*DatAn*	*CritTh*	*IntRe*	*EffCom*	*InfoLit*	*Tech*	*ColTe*	*ResO*
74.99 Below	195	225	224	229	132	147	216	193	0
75-79.99	9	4	2	0	35	38	7	11	8
80-84.99	10	1	4	1	39	33	4	22	49
85-89.99	7	0	0	0	10	7	2	4	49
90 Above	10	1	1	1	15	6	2	1	125
TOTAL	231	231	231	231	231	231	231	231	231

The table above summarizes a thorough rundown of students' grades from their research output concerning their performance outcomes on the Research Proficiency Exam. The students' comprehension and utilization of research methodologies, aptitude for data analysis, and competence in delivering well-organized and thorough research papers are all reflected in their grades and scores. This assessment attempts to shed light on the student's academic development and identify areas needing more attention and assistance to improve their research capacity.

Mean and Standard Deviation of Scores Obtained by the Grade 12 Students

Table 2. Research Skills

	Basic Writing	***Data Analysis***	***Critical Thinking***	***Interpreting Result***	***Effective Communication***	***Information & Literacy***	***Technological***	***Collaboration & Teamwork***
N	231	231	231	231	231	231	231	231
Missing	0	0	0	0	0	0	0	0
Mean	57.7	47.4	44.9	43.6	67.8	66.3	51.4	60.0
Median	56.7	46.7	46.7	46.7	73.3	70.0	53.3	63.3
Standard deviation	16.6	14.9	14.5	13.0	16.6	15.5	16.4	16.6
Minimum	13.3	10.0	10.0	10.0	10.0	26.7	10.0	20.0
Maximum	96.7	93.3	93.3	93.3	93.3	96.7	96.7	93.3

The research competencies of Grade 12 students exhibit significant variability when assessed across various skill sets. The above table details the importance of these results and what they might mean for teaching methods and student outcomes. The result will also provide an overview for research teachers on which areas they need to focus their attention on.

The average score for Basic Writing Skills is 57.7%, and the middle score is 56.7%. This means that the scores are spread out pretty evenly. A wide range of results (13.3 to 96.7) and a standard deviation of 16.6 show that some students are good at writing, but many may struggle with simple writing tasks. According to Amalia et al. (2021), teachers who teach English writing face seven problems: (1) students who don't know how to use correct grammar; (2) students who can't come up with ideas for English writing; (3) students who don't know enough English words; (4) students who don't want to learn English writing; (5) teachers who don't know how to manage their time well enough to teach English writing; (6) teachers who don't have enough English writing materials; and (7) teachers who don't have enough space to teach English writing. Further, the range of results shows how important it is to focus interventions to help students who aren't doing as well improve their writing skills.

The average score for data analysis skills is 47.4%, and the median score is 46.7%. This means most learners who answered were only somewhat good at this topic. The score ranges from 10.0 to 93.3, and the standard deviation of 14.9 shows much variation. The capacity to efficiently evaluate and interpret data has grown in importance as the academic environment changes, especially for students doing research (Jegatha Deborah et al., 2014). The inability of many students to acquire the skills required for data analysis can hamper their ability to advance and succeed as researchers (Alex-Assensoh, 2008). These results show that while some students are very good at analyzing data, a lot of them need more help to get better at these important skills necessary for research.

Critical thinking skills need a lot of work, as shown by the mean score of 44.9% and the median score of 46.7%. The wide range of results (10.0% to 93.3% and a standard deviation of 14.5) show that people have different critical thinking skills. According to Ramos (2018), essential thinking abilities must be established and developed in learners as they advance through the school system and deal with outcomes-based learning and 21st-century skills

in senior high school. Improving the curriculum and giving students more hands-on activities that encourage critical thought could help them become better at research in general.

The middle score for Interpreting Result Skills is 46.7%, and the mean is 43.6%. A standard deviation of 13.0 and a score ranging from 10.0 to 93.3 show a lot of variation, just like with other skill sets. According to Mutlu (2020), as cited in Mahdiannur & Romadhoni (2020), the ability to analyze and interpret data is the lowest. Nevertheless, the process of interpreting the results is essential to finishing laboratory-based inquiry activities. This variation shows that specific training is needed to correctly understand study results.

The mean score for effective communication skills is 67.8%, and the median score is 73.3%. This means that most students do better in this area. The positive skew in the data shows that some learners still need to work on their communication skills, even though many of them are very good at it. According to Bharathi (2016), one of the main factors contributing to educated unemployment is inadequate communication skills, which reduces the career prospects for recent graduates. The high average and wide range of scores (10 to 93.3) show the importance of working on speaking skills so that all students can clearly explain their research. According to the findings of Tizon (2019), senior high school teachers thought they were better communicators of the English language than other people. Thus, this skill requires better emphasis.

A mean score of 66.3% and a median score of 70.0% show the participants have good information and literacy skills. The spread of scores, from 26.7 to 96.7, and the standard deviation of 15.5 show some variation. Head (2013) reports that while some students are skilled at using information for their research, others need more assistance acquiring these skills.

This means that while many students are good at using information, others need more work. Students need to improve these skills to effectively gather and evaluate knowledge for their research. Higher education establishments must, therefore, adopt a proactive and comprehensive strategy for information literacy, making sure that students not only learn these abilities but also gain the flexibility to use them in a range of settings, from the classroom to the workplace and beyond (Head & Eisenberg, 2010; Head, 2013).

The middle score for technological skills is 53.3%, and the mean is 51.4%. The wide score range (10.0 to 96.7) and the standard deviation of 16.4 show that the grade 12 students are very different in how well they can use technology. Teachers are essential in developing digital literacy in students, as schools are responsible for developing literacy skills that transcend traditional print-based forms (Castillo-Martínez & Ramí-rez-Montoya, 2021). Teachers ought to establish a setting where the learners can investigate, experiment, and learn about the potential of technology. Students should also learn how to use digital technologies correctly and develop critical thinking abilities to assess material they find online.

The increasing dependence on technology in the research process underscores students' need to thoroughly comprehend how to navigate and utilize digital resources. In addition to acquiring technical skills, successful interaction with the digital environment necessitates cognitive, sociological, and affective abilities (Voinea et al., 2020). In addition to the ability to operate computers and software, students must also be able to critically evaluate the information they acquire and effectively communicate their findings (Fakhrudin & Haryanto, 2023). Because technology is being used increasingly in research, it is important to give students more training and resources to help them get better at using technology.

Collaboration and teamwork skills have a mean score of 60.0% and a median score of 63.3%, which means that most students do well in this area. On the other hand, the score range of 20.0 to 93.3 suggests that some students may have trouble working with others. Page & Donelan (2003) noted that efficient cooperation enables individuals to utilize their varied knowledge, expertise, and viewpoints to address intricate challenges that would be challenging to resolve independently. Additionally, it fosters transparent communication and

exchanging ideas, which can result in enhanced decision-making and superior outcomes.

Collaboration fosters the development of efficient communication and collaboration while promoting equal opportunities among team members (Medhi et al., 2019). Furthermore, collaborative research offers the potential to share ideas across different fields of study, acquire new abilities, secure funding, and achieve superior outcomes. These skills can be improved by working together on group projects and using joint programs.

The results show that Grade 12 students need a more complete way to improve their skills. Schools should consider putting in place programs specifically designed to improve the basic research skills of these students. Some could give students more chances to get coaching and mentoring and easier access to tools and academic help. Schools should also work on teaching kids how to think critically and solve problems, as these are important skills for doing well in college and the job market. According to Erogbogbo (2011) and Hoon et al. (2019), even academically gifted students often struggle to acquire strong research abilities.

Table 3. Research Output

	Research Output
N	231
Missing	0
Mean	88.8
Median	91
Standard deviation	5.56
Minimum	75
Maximum	99

The table above is the summary of grades obtained by the 231 grade 12 students from their research project. The average grade for all participants is 88.8, which is the mean value of the research output. With a median score of 91, half of the participants scored less than 91, and the other half scored more than 91. The student's grade in research some variation, with a standard deviation of 5.56, shows that it is not very high. averages 88.8, with the majority of scores falling within this range. Despite some variation, the standard deviation of 5.56 shows that it is not very high. The majority of participants' scores are relatively close to average.

Overall, the students' research project performance appears to have been strong, as indicated by the average research output score of 88.8. A slightly positively skewed distribution, where most students performed well but a small number of lower scores depressed the average, is indicated by a median score of 91, which is higher than the mean. The comparatively low standard deviation of 5.56 suggests that there is no statistically significant variation in the scores, implying that the students' performance is uniform.

With a mean score of 88.8, the students demonstrated a high level of performance, suggesting that most of them have a firm understanding of the practical research skills under evaluation. The low standard deviation indicates that the majority of students have performed similarly, which implies that they have had similar assistance and access to resources, which has resulted in consistency in their ability to conduct research. Gonzales et al. (2020) cited that there is an increase in research productivity once teachers establish their research capability. Teachers may examine the lower-scoring pupils more closely if they notice a small difference between the mean and median scores. Recognizing and comprehending these students' difficulties, specific support can be given to help them perform better.

Relationship between the Research Skills and the Research Output of Grade 12 Students

Table 4. Correlation Matrix

		Basic Writing	***Data Analysis***	***Critical Thinking***	***Interpreting Result***	***Effective Communication***	***Information & Literacy***	***Technological***	***Collaboration & Teamwork***	***Research Output***
Basic Writing	Pearson's r	—								
	Df	—								
	p-value	—								
Data Analysis	Pearson's r	0.460	—							
	Df	229	—							
	p-value	< .001	—							
Critical Thinking	Pearson's r	0.281	0.341	—						
	Df	229	229	—						
	p-value	< .001	< .001	—						
Interpreting Result	Pearson's r	0.394	0.406	0.416	—					
	Df	229	229	229	—					
	p-value	< .001	< .001	< .001	—					
Effective Communication	Pearson's r	0.396	0.363	0.465	0.375	—				
	Df	229	229	229	229	—				
	p-value	< .001	< .001	< .001	< .001	—				
Information & Literacy	Pearson's r	0.382	0.448	0.373	0.415	0.635	—			
	Df	229	229	229	229	229	—			
	p-value	< .001	< .001	< .001	< .001	< .001	—			
Technological	Pearson's r	0.444	0.444	0.435	0.403	0.613	0.661	—		
	Df	229	229	229	229	229	229	—		
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	—		
Collaboration & Teamwork	Pearson's r	0.494	0.314	0.354	0.335	0.438	0.527	0.569	—	
	Df	229	229	229	229	229	229	229	—	
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001	—	
Research Output	Pearson's r	0.105	0.218	0.055	0.146	0.206	0.254	0.239	0.135	—
	Df	229	229	229	229	229	229	229	229	—
	p-value	0.113	< .001	0.405	0.026	0.002	< .001	< .001	0.041	—

The correlation matrix above shows a weak and strong relationship between research skills and research output. The significance of a result is ascertained in the study of statistical significance using the p-value, with 0.05 typically serving as the threshold for significance. The result is considered statistically significant if the p-value is less than 0.05, suggesting that the variable and the research output are related.

Both basic writing and critical thinking skills have p-values of 0.113 and 0.405, respectively, which show no statistical significance. These two skills likely have little to no effect on the research output. According to Decker et al. (2016), spelling, handwriting, phonological awareness, rapid letter-making, orthographic processing, and fine motor skills encompass basic writing abilities. Similarly, critical thinking is actively conceiving, applying, analyzing, synthesizing, and assessing data to inform opinion and behavior (Adhikari, 2023). Writing abilities may include text production, idea relations, idea construction, metacognition, and revision, and they are essential for both academic achievement and civic engagement (Glynn & Muth, 1994). Most likely, these two identified research skills should come together, as they are essential to the foundation of research.

Conversely, the p-values for Interpreting Results (0.026), Effective Communication (0.002), and Collaboration and Teamwork (0.041) indicate moderate to strong correlations with research output. This suggests that these abilities are important for generating high-caliber research. Togher (2013) concluded that researchers must possess critical skills such as effective communication, data interpretation, and collaboration to achieve high-quality research outcomes.

Meanwhile, more significant research outcomes are probably produced by researchers who can communicate their findings, interpret data clearly, and collaborate well with others. Although there are some obstacles to overcome through strategic approaches, collaborative learning has been found to improve students' motivation and social skills ("Pedagogia: a ciência da educação", 2023). However, according to Sun et al. (2019), an excessive number of collaborations may not necessarily improve the quality of research outcomes. In fact, they may worsen it.

Similarly, with p-values less than 0.001, technological, information Information literacy, and data analysis skills show the strongest correlations with research output. This robust correlation emphasizes how crucial these abilities are to the research process. According to Cherchye & Abeele (2005), the efficacy and efficiency of research projects and the production of quality and trustworthy research results are the by-products of proficiency in data analysis, information literacy, and technology. Fundamentals of information literacy that significantly impact student learning outcomes include exposure to research opportunities, using data to test research questions, and developing communication skills (Caravello et al., 2008).

Similarly, technological advancement has been shown to increase energy efficiency, which favorably affects research results (Wei et al., 2016). Moreover, the development of technology and technological capacities has a major influence on research results and technical efficiency (Deraniyagala, 2001). Technology advancement is crucial to promoting research findings.

The correlation matrix shows that while critical thinking and basic writing have less influence on research output, collaboration, teamwork, and skills like interpreting results are more vital. Most importantly, attaining high research productivity and quality requires a strong foundation in data analysis, information literacy, and technological proficiency. Lloyd (2006) opined that one must possess data analysis skills to interpret complex datasets accurately. While strong information literacy enables researchers to assess previous work critically and elevate the caliber of their own investigations (Webber & Johnston, 2000), in contemporary research practices, technological competence is essential as it impacts data collection, analysis, and dissemination (Chaganava, 2023). This emphasizes how important it is for researchers to prioritize and acquire these essential skills to improve their research capacities and results.

Accordingly, Basic Writing Skills and Critical Thinking Skills should not be included in the factor loadings for mediation analysis since the two skills showed no statistical significance in the research output. All other skills, including the dependent variable- the research output, will move forward to the next level of analysis. The mediation analysis of the research output will be conducted using the remaining skills. The results of the analysis will then be used to assess the effectiveness of the research.

Confirmatory Factor Analysis

Before mediation analysis or any other structural equation modeling (SEM) is conducted, a confirmatory factor analysis (CFA) is necessary to validate the factor structure of variables. It enables the researcher to investigate the theory that there is a connection between each variable, whether independent or dependent. Based on actual data, CFA supports or refutes preconceived notions and models. To determine the validity and reliability of the measured constructs, CFA provides information on the number of factors and the pattern of indicator-factor loadings.

Table 5. *Factor Loadings*

Factor	***Indicator***	***Estimate***	***SE***	***Z***	***P***
Factor 1	Data Analysis	8.09	0.963	8.40	< .001
	Interpreting Result	6.71	0.846	7.93	< .001
	Effective Communication	12.23	0.982	12.45	< .001
	Information & Literacy	12.75	0.884	14.43	< .001
	Technological	13.42	0.935	14.35	< .001
	Collaboration & Teamwork	10.64	1.034	10.29	< .001
	Research Output	1.62	0.381	4.25	< .001

All the factor loadings are statistically significant ($p < 0.001$), indicating that each indicator significantly contributes to the underlying construct. With z-values of 14.35, 14.43, and 12.45 for technological, information and literacy, and effective communication, respectively, these factors are highly regarded. These high factor loadings suggest that the underlying construct's definition under assessment depends critically on information literacy, technological competence, and effective communication.

Although comparatively weaker, the significantly lower factor loading for research output suggests a relationship with the underlying construct. Research output is the dependent variable in the model and is essential even with its weaker factor loading. Incorporating research output is imperative as it provides a direct gauge of the efficacy and productivity of research endeavors, mirroring the pragmatic consequences of the competencies under examination.

From the factor loadings above, only technological information and literacy will be used in the model since these two skills have the highest z-values. Their substantial and statistically significant contributions to the underlying construct form the basis of this decision. The model attempts to capture the most critical components that propel research success by concentrating on these essential competencies.

Table 6. Goodness of Fit Indices

Goodness of Fit Indices	*Value*	*Level of Acceptance*	*Reference*
Chi-squared/df	0.230	< 5.0	Marsh & Hocevar (1985)
CFI	0.993	> 0.90	Bentler (1990)
TLI	0.990	> 0.90	Bentler & Bonett (1980)
RMSEA	0.0329	< 0.08	Browne & Cudeck (1993)

The goodness-of-fit indices provided are within their respective levels of acceptance, indicating that the model fits the observed data very well. For example, the chi-squared/df value of 0.230 is significantly lower than the threshold of 5.0, indicating an excellent fit. This value shows that the model fits the data very well; lower values suggest a better fit. An excellent fit is indicated by the Comparative Fit Index value of 0.993, which is higher than the 0.90 threshold. A better fit is suggested by values closer to 1, and this value is extremely close to 1, suggesting a very good model fit.

Meanwhile, an excellent fit is indicated by the Tucker-Lewis Index value of 0.990, which is higher than the 0.90 threshold. This value indicates a very good model fit; similarly to the CFI, values closer to 1 indicate a better fit. A good fit is indicated by the root mean square error of approximation value of 0.0329, which is less than the 0.08 threshold. A lower RMSEA value indicates a better fit, and this number implies that the model fits the data well.

Mediation Analysis

Mediation analysis is a statistical method for understanding how an independent variable influences a dependent variable through a mediator variable. Research using this technique can decompose total independent

variable effects on dependent variables into direct and indirect effects, providing insights into the underlying processes. Mediation analysis identifies and quantifies the causal pathways through which effects are caused, allowing a deeper understanding of complex interactions within the data.

The previous table reported the factor loadings of the variables. Two of these variables have reached the z-values of 14.43 and 14.45, which are identified as information and literacy and technological skills, respectively. Only one of these skills will play a mediator role. At the same time, the other will be a predictor, and research output will be the dependent variable.

Technological Skill as a Mediator

Table 7. Mediation Estimates: Technological Skills

Effect	*Label*	*Estimate*	*SE*	*Z*	*P*	*% Mediation*
Indirect	a × b	0.0301	0.0201	1.50	0.134	33.2
Direct	C	0.0607	0.0302	2.01	0.044	66.8
Total	c + a × b	0.0908	0.0228	3.99	< .001	100.0

The table above illustrates the direction and impact of dependent and independent variables with another variable that acts as a mediating variable. In this case, information and literacy are the predictors, while technology is the mediator.

The indirect effect (a × b) represents the effect of information and literacy on the research output through the mediator, technological skills. The estimate of 0.0301 suggests a small indirect effect. However, the p-value of 0.134 is greater than 0.05, indicating that the indirect effect is not statistically significant. The percentage of mediation is 33.2%, indicating that 33.2% of the total effect is mediated through the mediator.

The direct effect (c) represents the effect of the research output on information and literacy, not through the mediator. The estimate of 0.0607 suggests a moderate direct effect. The p-value of 0.044 is less than 0.05, indicating that the direct effect is statistically significant. The percentage of mediation is 66.8%, indicating that 66.8% of the total effect is direct.

The total effect (c + a × b) represents the combined effect of the research output on information and literacy, including both direct and indirect paths. The estimate of 0.0908 suggests a moderate total impact. The p-value of less than 0.001 indicates that the total effect is highly significant. The percentage of mediation is 100.0%, showing the total contribution of both direct and indirect effects.

Table 8. Path Estimates: Technological Skills

			Label	*Estimate*	*SE*	*Z*	*P*
Information & Literacy	→	Technological	a	0.6982	0.0521	13.39	< .001
Technological	→	Research Output	b	0.0431	0.0286	1.51	0.132
Information & Literacy	→	Research Output	c	0.0607	0.0302	2.01	0.044

The estimate of 0.6982 indicates a strong positive relationship between information and literacy and technological skills. The z-value of 13.39 and the p-value of less than 0.001 show this relationship is highly statistically significant.

The estimate of 0.0431 indicates a weak positive relationship between technological skills and research output. However, the z-value of 1.51 and the p-value of 0.132 suggest that this relationship is not statistically significant.

The estimate of 0.0607 indicates a moderately positive relationship between information, literacy, and research output. The z-value of 2.01 and the p-value of 0.044 show this relationship is statistically significant.

These path estimates indicate that technological skills are strongly influenced by information and literacy. Information and literacy

have a direct and significant impact on research output. However, technological skills do not significantly mediate the relationship between Information literacy, and research output. This indicates that although technological skills and research output are positively influenced by information and literacy, the relationship between technological skills and research output is minimal in this model.

Based on the mediation analysis, information and literacy directly and indirectly impact research output. This indicates that information and literacy both directly and indirectly impact research output. In light of this, the findings demonstrated that technological skills do not mediate between research output, information, That information and literacy both directly and indirectly impact research output. information and literacy.

Information & Literacy as a Mediator

Table 9. Mediation Estimates: Information & Literacy

Effect	*Label*	*Estimate*	*SE*	*Z*	*P*	*% Mediation*
Indirect	a × b	0.0380	0.0191	1.99	0.047	0.047
Direct	C	0.0431	0.0286	1.51	0.132	0.132
Total	c + a × b	0.0811	0.0217	3.75	< .001	< .001

The table above illustrates the direction and impact of dependent and independent variables with another variable that acts as a mediating variable. In this case, technology is the predictor, while information and literacy are the mediators.

The indirect effect (a × b) represents the effect of the research output on the technological skills through the mediator, information and literacy skills. The estimate of 0.0380 suggests a small indirect effect. The p-value of 0.047 is less than 0.05, indicating that the indirect effect is statistically significant. The percentage of mediation is 46.8%, indicating that 46.8% of the total effect is mediated through the mediator.

The direct effect (c) represents the effect of the research output on the technological skills, not through the mediator. The estimate of 0.0431 suggests a moderate direct effect. However, the p-value of 0.132 is more significant than 0.05, indicating that the direct impact is not statistically significant. The percentage of mediation is 53.2%, indicating that 53.2% of the total effect is direct.

The total effect (c + a × b) represents the combined effect of the research output on technological skills, including both direct and indirect paths. The estimate of 0.0811 suggests a moderate total impact. The p-value of less than 0.001 indicates that the total effect is highly significant. The percentage of mediation is 100.0%, showing the total contribution of both direct and indirect effects.

Table 10. Path Estimates: Information & Literacy

			Label	*Estimate*	*SE*	*Z*	*p*
Technological	→	Information & Literacy	A	0.6259	0.0467	13.39	< .001
Information & Literacy	→	Research Output	B	0.0607	0.0302	2.01	0.044
Technological	→	Research Output	C	0.0431	0.0286	1.51	0.132

The estimate of 0.6259 indicates a strong positive relationship between technological skills and information and literacy. The z-value of 13.39 and the p-value of less than 0.001 show this relationship is highly statistically significant.

The estimate of 0.0607 indicates a moderately positive relationship between information, literacy, and research output. The z-value of 2.01 and the p-value of 0.044 show that this relationship is statistically significant.

The estimate of 0.0431 indicates a weak positive relationship between technological skills and research output. However, the z-value of 1.51 and the p-value of 0.132 indicate that this relationship is not statistically significant.

These path estimates indicate that technological skills are strongly influenced by information and literacy, and that information and literacy directly and significantly impact research output. However, technological skills do not considerably mediate the relationship between information, literacy, and research output. This indicates that although technological skills and research output are positively influenced by information and literacy, the relationship between technological skills and research output is minimal in this model.

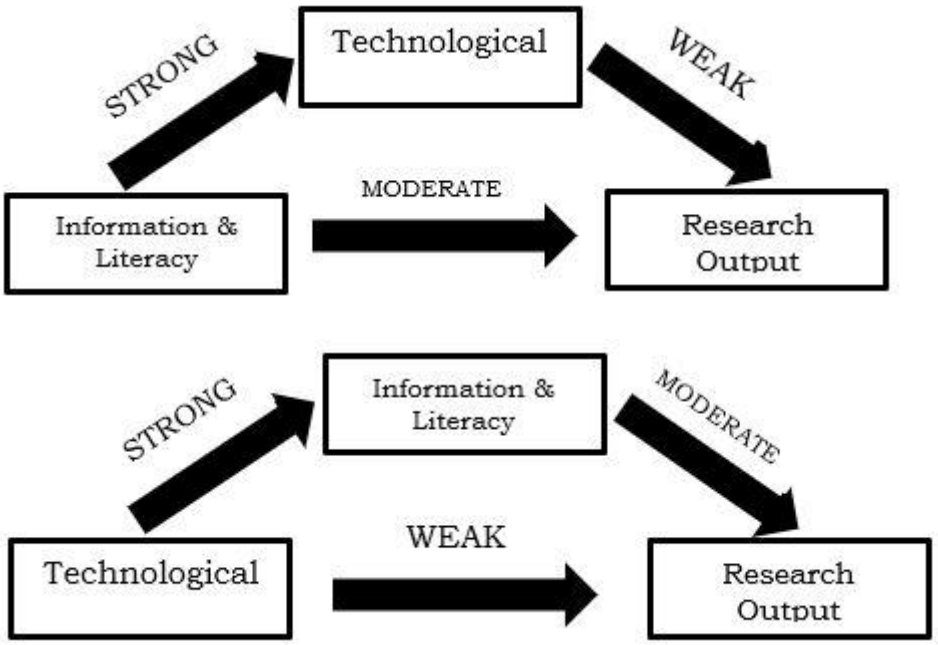

Figure 3. Comparison of the Two Mediation Models

As a result of the two research skills that act as mediators and predictors of research output, it is interesting to note that if technological skill is to be used as a mediator between information and literacy and research output, there will be a strong correlation between information and literacy and research output. However, the indirect influence of the mediator on the research output is weak, as opposed to the moderate influence of information and literacy as a mediator. Alternatively, information and literacy's direct effect on research output when technology is the mediator has a positive correlation. However, the relationship is weaker than that between technology and research output when information and literacy are the mediators. Nevertheless, even if technology's direct effect on research output is weak, the latter analysis would be considered since the mediator, information and literacy, would serve as an intermediary. Further Information & Literacy hold the two variables together with a moderate to strong connection.

The Model

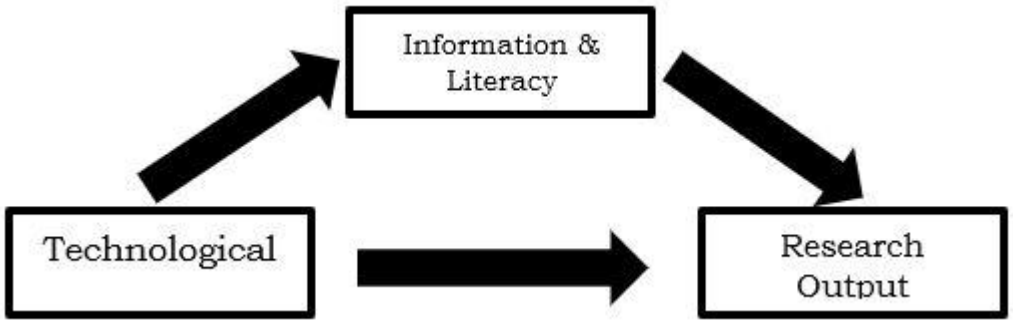

Figure 4. The Mediation Model

Information literacy is critical to moderating the connection between technological skills and research output. According to Supriyanti et al. (2020), educational opportunities can improve information literacy and critical thinking while giving access to content explored and expanded in scientific research. Information literacy abilities have a substantial impact on research output, even though technological competencies are crucial (Wang et al., 2014). Information literacy encompasses the ability to operate computer and network technologies, along with critical thinking, problem-solving, and research skills (Wang et al., 2014). It is pivotal in enhancing research productivity, especially considering factors like socioeconomic status, academic qualifications, and work experience (Ahmed & Sunday, 2019).

Hunsapu et al. (2023) emphasized the significance of information literacy outside of traditional library settings by highlighting its development into a multidisciplinary field across various disciplines. Additionally, Adesola & Madukoma (2022) showed that among doctorate students, information literacy, research productivity, and research self-efficacy were all positively correlated. This demonstrates how socioeconomic factors mediate the relationship between research productivity and information literacy skills (Ahmed & Sunday, 2019).

According to studies, information literacy is essential for graduate students to acquire to become proficient researchers (Ocak & Ataseven, 2016). There is so much more for learners who have started doing research work. Additionally, the effect of information literacy abilities on students at postsecondary institutions' use of e-library resources highlights the significance of these abilities for research productivity (Ekong & Ekong, 2018). Stakeholders can work together to create activities supporting research skills development by incorporating information literacy skills into academic programs like biotechnology degrees (Ward & Hockey, 2007).

Taheri et al. (2020) said postgraduate students' health literacy and research productivity depend on developing information literacy skills. Students learning outcomes and knowledge acquisition can be significantly enhanced by developing their information literacy skills through blended learning approaches (Setyoko et al., 2023). Furthermore, contextualized learning experiences are crucial for teaching information literacy, as evidenced by the effectiveness of teaching information literacy through practical research projects as opposed to instruction alone ("New Setting, Same Skill: Teaching Geography Students to Transfer Information Literacy Skills From Familiar to Unfamiliar Contexts", 2016).

Additionally, Berutu et al. (2019) stressed the importance of using a variety of information sources by proposing a strategy to improve information literacy based on digital and library resources. Information literacy instruction, such as in school libraries, promotes positive educational development and gives students the tools they need to succeed academically and work with research (Louderback, 2017). Employers looking to fill skilled positions highly value proficiency in information

and communication technology (ICT) (Moro et al., 2021).

To equip students with the knowledge and skills needed for 21st-century learning, digital literacy is essential in the classroom (Azzahro et al., 2023). In order to meet students' emotional needs during the research process, libraries should incorporate effective learning outcomes into their instruction (Cahoy & Schroeder, 2012). Peer review processes greatly influence information literacy outcomes, which emphasizes how crucial it is to locate, assess, and use information wisely for lifelong learning (Zwicky & Hands, 2015).

Practical Implications for Teaching Strategies in Enhancing Research Competencies

The findings of this study provide valuable insights into the development of research skills among senior high school students, particularly highlighting the role of Information and Literacy Skills in mediating Technological Skills and research output. These results have significant implications for teaching strategies, professional development, and potential interventions aimed at improving students' research competencies.

The study emphasizes how important it is for teachers to incorporate information literacy and digital literacy into research education. To guarantee that students acquire strong information literacy skills, teachers should place a strong emphasis on assessing sources, fact-checking, and the ethical use of information. Students will be able to efficiently filter pertinent research materials by incorporating lessons on recognizing reliable sources, comprehending plagiarism, and using appropriate citation styles. Students' capacity to carry out significant research can also be strengthened by involving them in real-world research projects that call for the application of both information literacy and technological skills. Techniques like case studies, group research projects, and practical experiments can improve data analysis and critical thinking abilities.

Furthermore, Continual professional development (CPD) programs should be put in place to make sure that educators are prepared to help students develop research competencies. Teachers can learn how to use online databases, citation management software, and AI-assisted research tools efficiently by attending workshops on digital research tools. Students will also be given the right direction in carrying out reliable research thanks to capacity-building workshops that teach source evaluation, academic integrity, and ethical research practices. A comprehensive support system for students can also be established by promoting interdisciplinary collaboration among librarians, IT instructors, and research teachers. Professional learning communities, which allow teachers to share best practices in research instruction, should be encouraged by schools.

Finally, teacher preparation, student research competencies can be greatly improved through focused interventions and organized training programs. In-depth instruction in literature reviews, methodology selection, data collection, and interpretation can be obtained through research boot camps and seminars. Peer collaboration and experiential learning can be promoted by establishing mentorship and peer-led research programs in which senior students or alumni with extensive research backgrounds mentor younger students. In order to enable students to acquire technological skills in addition to research abilities, schools should also invest in digital research labs furnished with cutting-edge instruments for data analysis, online collaboration, and academic writing software. Additionally, remedial classes or individualized coaching sessions can offer focused assistance to meet each student's unique learning needs if they are having trouble with information literacy and research writing.

Conclusion

The following null hypotheses are accepted in this study: There is a strong correlation between information and literacy, technology, practical communication skills, and research output. Consequently, learners who excel in information, literacy, and technological aspects produce high-quality research. As a result, the study concludes that technological skills do not mediate information, literacy, or research output.

Further, the result of the study reveals that data analysis, critical thinking, and interpreting results are the skills most learned by senior high school students. While effective communication, information and literacy, and collaboration and teamwork skills are what students are good at. Further statistical analysis demonstrated that information and literacy skills can mediate any research skills with the research output.

Recommendations and Limitations

Based on the study's results, a number of suggestions are made to help senior high school students become more proficient researchers. The study's generalizability is constrained by its sample size and particular context. To improve validity, future studies should take into account larger sample sizes, a wider range of educational settings, and a student diversity. Triangulation techniques like teacher assessments and performance-based evaluations should also be used to address potential biases, such as self-reported data.

In terms of policy, curriculum designers ought to incorporate the following fundamental skills: technology, data analysis, critical thinking, and basic writing, either as standalone courses since most of these skills are integrated into already-existing ones. To strengthen students' research skills, Grade 11 should prioritize Media and Information Literacy and Empowerment Technologies in addition to Statistics and Probability, if possible these three courses must have pre-requisites. To improve students' literacy and research skills, schools should also include more technology-driven projects and communication exercises. Additionally, writing and critical thinking-focused interventions ought to be created, especially for the Reading and Writing course and research-related courses.

To put Practical Research 1 and 2 into practice, schools must incorporate thorough information literacy instruction to guarantee that students gain the skills necessary to access, assess, and use information efficiently. In order to engage students in projects that call for data analysis, report writing, and research presentation, learning modules should be created to integrate a variety of skills. In order to prepare students for the demands of senior high research, it is also important to emphasize data analysis, critical thinking, and result interpretation in subjects like language, science, and mathematics starting in junior high school.

Regular evaluations and tailored feedback should be used to track students' development of research-related skills in order to promote continuous improvement. Standardized assessments, such as written exams and project-based evaluations, ought to be established by the Department of Education. In order to improve their capacity to effectively mentor students, educators should also have access to opportunities for ongoing professional development that keep them abreast of current research methodologies and technological developments. Hence, they are encourage to take further studies like taking master's degree where research subjects are highly focused.

Important topics for future study should include how research proficiency, information literacy, and effective communication are integrated in senior high school; how information and communication literacy affect research competence; and how project-based learning affects students' academic abilities. Schools can create a more research-oriented learning environment that gives students the tools they need to succeed academically and professionally by addressing these factors.

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