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Does Mentoring Directly Improve Students' Research Skills? Examining the Role of Information Literacy and Competency Development

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Abstract: This work proposes a structural model highlighting the research skills of undergraduate students. Due to the stages in their research project implementation, mentoring students becomes a crucial initiative in higher education institutions. Despite substantial progress in the literature linking mentoring and skills development, there is a lack of greater emphasis on research skills, especially for undergraduate students facing research work for the first time. Consequently, the direct relation between mentoring and research skills may not be straightforward. Thus, driven by social learning theory, the proposed model highlights the mediating effects of information literacy constructs and competency development on the relationship between mentoring and research skills. An empirical study of 539 participants via Partial Least Squares–Structural Equation Modeling supports six of the seven hypothesized paths. Three major theoretical contributions arise from the findings. Firstly, mentoring improves information-seeking skills and information-sharing behaviors and facilitates students' competency development due to the technical knowledge transfer from the faculty mentor to student mentees. Secondly, information literacy constructs and competency development promote research skills, emphasizing that students with those behaviors and capacities will achieve enhanced research skills. Finally, our findings suggest that mentoring does not directly translate to improved research skills; instead, information-seeking and sharing behaviors and competency development fully mediate such a link. Thus, mentors must shape these behaviors for mentoring to develop students' research skills. Theoretical and practical insights are outlined from these findings for university leadership to inform the design of mentoring initiatives for undergraduate students.

Keywords: mentoring; research skills; information seeking; information sharing; competence development; undergraduate research

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1. Introduction

The active involvement of undergraduate students in scientific research yields numerous advantages for their academic and professional careers [1]. Engaging in research improves students' propensity to publish in high-impact research journals, experience professional fulfillment, and achieve greater economic and academic stability [2]. Barnett [3]

argued that undergraduate research and inquiry are crucial for developing higher-order skills and academic dispositions that prepare students for the complexity of modern society and the economy. This growing consensus emphasizes the need for learning opportunities, prioritizing research and inquiry-based learning. Typically, undergraduate research projects involve multiple stages, such as conducting a literature review, devising a research plan, collecting and analyzing data, and presenting the results in a thesis manuscript, journal article, or conference proceeding. Throughout the research process, students typically receive various types of mentoring support, which could be formal or informal, and students can derive benefits from having multiple mentors who offer diverse forms of support [4]. Mentoring undergraduate research has been recognized as a highly effective practice that enhances the quality of education and learning in higher education [5,6]. Among those pivotal practices is the faculty-mentored undergraduate research experience, in which students collaborate with expert faculty mentors on discipline-based research activities [7]. However, mentoring extends beyond the formal faculty and undergraduate student relationships, which can involve various individuals (e.g., university staff, peers, family, and friends) and can occur in either one-on-one connections or small group settings, all of which contribute to student's educational success [8–10]. In the work of Mullen and Klimaitis [11], they differentiated mentoring from coaching, induction, or training. They emphasized that mentoring is an active process, not therapy, a unilateral endeavor, a panacea, a temporary fix, or a singular intervention. Some manifestations include providing students with written feedback on their thesis manuscripts to improve their academic writing [12]. Also, regular one-on-one consultations between mentors and students, including verbal feedback, result in successful thesis completion and higher student satisfaction [13]. During mentoring, a complex process of communication, collaboration, conflict, and understanding of mentor–student interactions occurs [5]. The complexity of the mentorship experience in undergraduate research is augmented by the students' emerging self-development [5].

Mentorship is a symbiotic relationship where the faculty mentor fosters the student's growth professionally and personally, offering opportunities for professional skills development, networking, and confidence [14]. Extensive research has been conducted over the past three decades on the benefits of mentorship [15]. However, despite significant milestones in the field, Crisp et al. [16] acknowledged that the definitions of mentorship had been a subject of debate and evolution over time, demonstrating the intricate nature of understanding and defining mentorship. Gershenfeld [17] found that the primary function of mentoring is academic support, followed by psychosocial/emotional support and role modeling. Mentoring aims to enhance skills and abilities, providing broad support and focusing on individual growth and achievement [18,19]. Studies in the domain literature found that mentoring can improve information-seeking skills, influence information-sharing behavior, aid in competency development, and improve research skills by providing guidance, support, and feedback [5,20–22]. Case [23] associated information seeking with the actions carried out to find information that meets the information requirements of individuals in their everyday undertakings. Lopatto [24] and Russell et al. [25] argued that mentorship in undergraduate research goes beyond faculty members, which suggests that other research staff, academic librarians, postdoctoral fellows, graduate students, and undergraduate peers play important technical or psychosocial roles in this process. For instance, Blaney et al. [26] highlighted the critical aspect of cascading mentorship, where senior students and staff, with postdoctoral fellows (or postdocs) as a case in point, mentor graduate students in laboratories. Their findings emphasized the hands-on support and troubleshooting students receive from postdocs, which significantly impact students' mental health. Chlomoudis et al. [27] observed that students seek information to improve their academic or professional performance. In consonance with other information and communication technologies, the internet has accelerated this process. Along this line espouses the criticality of information literacy as it involves identifying, retrieving, evaluating, and using information effectively, which are crucial for successful information-seeking skills. Research on information literacy and information seeking can help individuals develop strong

information-seeking skills essential for conducting high-quality research and achieving academic and professional goals [28].

Meanwhile, information sharing can improve research skills by enabling knowledge exchange, mutual learning, and collaboration. Mentees can gain fresh insights and diverse perspectives that can aid in refining research questions, creating more robust designs, and generating innovative and impactful findings. With effective and consistent mentoring initiatives, students develop varying degrees of competence. Competence is the ability to handle specific situations or tasks successfully. Its requirements will change with several factors, such as internationalization, new production methods, and the widespread implementation of information technology [29–31]. Competency development integrates skills, knowledge, and job attitude to achieve desired workplace behavior and performance and can be formal or informal, with the latter regularly occurring during work and characterized by a lack of focus on learning [32–35]. The relationship between undergraduate research and mentorship is an area that has received significant attention in academic literature. While there is some evidence to suggest that mentorship can positively impact undergraduate research skills, there is still a need for further exploration of this relationship, as previous findings were not too straightforward.

This study seeks to address the existing gap in the literature on mentoring by empirically investigating the influence of mentorship on the development of undergraduate students' research skills, using Bandura's social learning theory as a guiding framework. Bandura's social learning theory provides a theoretical lens for mentoring, suggesting that learning occurs in a social context through observation and modeling. Mentees look to their mentors as role models to develop new skills or gain knowledge from a mentoring relationship. The mentor demonstrates the skills and provides motivation and expectations for the mentee [5]. When the mentor is regarded as a role model, the mentee gains confidence, self-efficacy, and exemplary job performance [36]. While the mentoring approaches may differ, the main goal remains the same: for the mentor to act as a useful example for the mentee's progress. With insights into critical factors in developing research skills, this work explores the relationship between mentorship, information-seeking skills, information-sharing behavior, competency development, and research skills. The study aims to (1) develop an empirical model to demonstrate how mentorship contributes to the formation of information-seeking skills, information-sharing behavior, competency development, and research skills; (2) test the model with empirical data using Partial Least Squares–Structural Equation Modeling; and (3) examine the mediating effect of information literacy (i.e., information-seeking skills and information-sharing behavior) and competency development on the relationship between mentoring and research skills.

Furthermore, this study offers theoretical contributions. First, this work provides a better understanding of the mentorship's role in enhancing research skills by applying Bandura's social learning theory and testing its applicability to the model in explaining research skills among undergraduate students. This theoretical contribution advances our understanding of how mentorship can impact research skills. Second, this work offers insights into how mentorship can enhance undergraduate students' research skills. The findings of this work could provide insights into developing educational and training programs that aim to improve research capabilities among undergraduate students. Theoretical contributions of this work hold significance in developing countries, such as the Philippines, where the development of research skills among undergraduate students has become increasingly important. This study sheds light on the role of mentorship in developing research skills, which can help universities in the Philippines and other similar countries craft effective mentoring strategies for enhancing research skills among their students. Moreover, the practical implications of these theoretical contributions can be extended to universities worldwide. The insights provided by this study can guide university administrators in designing and implementing effective research mentoring programs that can enhance the research performance of their institutions. The knowledge gained from

this study can help universities build a pool of skilled researchers who can advance an understanding in their respective fields and positively impact society.

The rest of this paper is arranged as follows: Section 2 outlines the review of the relevant literature and hypothesis development that guides the proposed structural model. Section 3 describes the study methods, including sampling and data collection, the profile of the participants, and data analysis. Section 4 reports the results of the measurement and structural models. Section 5 discusses the study findings and their insights. It ends with some concluding remarks and pathways for future works in Section 6.

2. Literature Review and Hypotheses Development

2.1. Bandura's Social Learning Theory

Bandura's social learning theory highlights the influence of social interactions on shaping a person's characteristics, behaviors, and skills, emphasizing the role of performance feedback and modeling persuasion [37]. It was deemed the first to include "modeling" or "vicarious learning" as a form of social learning [38,39]. Social learning theory acts as a link between behaviorism, which focuses on modifying external behavior through reinforcement and repetition, and cognitive theory, emphasizing the cognitive aspects of learning beyond routine memorization [37]. Furthermore, self-education and self-development play a crucial role in this process, involving self-regulation and the ability to guide oneself, make choices, and navigate challenges, including moral conduct [40–42]. In the context of social learning theory, Edinyang [38] established the difference between "imitation" and "modeling". Imitation is the learner's capability to reproduce observed behavior, whereas modeling involves a more intricate process with four crucial steps to facilitate successful observational learning. Bandura [42] outlined a process by which people learn through modeling and observation: (1) observing behavior, (2) internalizing it through cognitive processes, (3) replicating it through personal actions, and (4) receiving positive feedback to enhance motivation and self-efficacy, leading to improved performance, especially for individuals with high self-efficacy. Bandura [41] asserted that the presence of these components is pivotal in influencing whether or not imitation occurs when exposed to a model.

2.2. Mentoring

In the context of undergraduate research projects, mentorship is a more bonded and symbiotic relationship in which the faculty mentor fosters student growth professionally and personally [14,43]. In a mentoring relationship, mentees consider the mentor a role model for developing new skills or gaining knowledge. The mentor demonstrates the skills and provides motivation and expectations for the mentee [5]. Mentoring offers professional skills development, networking, professional values and attitudes, and confidence [14,44]. It is considered a critical approach for developing research skills and promoting faculty success [20]. Symbiotically, mentoring is an efficient approach for emerging researchers to understand better how academics conduct research, enhance their research skills, and build confidence in advancing their research interests [21]. Although mentoring approaches may differ, the main goal is for the mentor to serve as a valuable role model for the mentee's growth. The primary objective of mentoring is to enhance skills and abilities, which requires accommodating various interpersonal styles and expectations [21]. Jacobi [18] identified three aspects of mentoring: (1) focus on individual growth and achievement, (2) broad forms of support (i.e., professional and career development), and (3) the personal and mutual nature of mentoring relationships. Luna and Cullen [45] pointed out that mentoring relationships could take various forms, such as informal or formal, short-lived or long-term, and can be either planned or spontaneous. Furthermore, Mullen and Klimaitis [11] provided an overview of the nine diverse classifications of mentoring alternatives derived from the empirical literature on educational mentoring. Recent works on mentoring focus on peer mentoring or cascading (see Blaney et al. [26]; Lorenzetti et al. [46]) and virtual or e-mentoring (see Tinoco-Giraldo et al. [19]).

In mentoring, a mentor can assist an individual in identifying and prioritizing their information needs and developing effective strategies for discovering and assessing information. A mentor can also provide feedback on the quality of the information, allowing the mentees to improve their information-seeking skills [20]. For instance, a mentor could introduce mentees to new sources of information and alternative research methods, broadening their understanding of the research process and assisting them in developing a more sophisticated approach to information seeking. Also, mentoring influences information-sharing behavior by creating a supportive environment where people feel comfortable sharing their knowledge and experiences with others [21]. Individuals may become more confident in their abilities and more willing to share their insights and perspectives with the help and encouragement of a mentor [20]. A mentor may also demonstrate the value of sharing knowledge and expertise with others by modeling positive information-sharing behaviors. Mentoring can help build more robust and collaborative students by fostering a culture of information sharing, where individuals can learn from one another and achieve their goals together. Also, mentoring supports competency development by providing guidance, support, and feedback as they gain new knowledge and skills [5,11]. A mentor helps identify areas in which mentees need to improve their competence and can provide resources and support to achieve their goals. For instance, mentors can provide valuable perspectives and guidance by sharing their own experiences and insights, assisting the individual to overcome challenges and progress in their development. This may boost the mentees' confidence and self-efficacy for continuous growth and improvement. Overall, mentoring can be an effective tool for promoting competency development and assisting individuals in reaching their full potential. Consequently, mentoring improves research skills by providing guidance, support, and feedback throughout the research process [22]. For instance, mentors offer feedback, identify areas for improvement, and provide encouragement and motivation.

Several studies emphasized the influence of mentoring on the performance of undergraduate students in the research context. Haege and Fresquez [47] explored the effects of mentoring strategies. They examined their impact on student success and academic skill development by focusing on a diverse population of students at a public, minority-serving institution. Palmer et al. [5] analyzed the intertwined relationships between mentoring, undergraduate research, and student identity development, focusing on the outcomes of mentored undergraduate research to better understand the relationships and develop a research agenda that informs the practice of mentoring undergraduate research in higher education. Furthermore, Agricolo et al. [48] analyzed mentors' diagnostic behavior by outlining various traits that mentors use to assess students' research skills. Nolan et al. [49] examined the benefits and barriers of undergraduate research experiences in statistics from the perspective of students, faculty mentors, and institutions. Thus, mentored research benefits diverse students and does not affect their timely graduation rates. The quality of mentoring, including socioemotional and culturally relevant mentoring, and the duration of the mentorship influence students' learning and development during research experiences [47]. Blaney et al. [26] focused on cascading mentorship, which sheds light on the distinct mentoring role of postdocs and explores the nature and potential outcomes of interactions between students and postdocs.

Nevertheless, several studies have explored the relationship between undergraduate research and mentorship. Some of these studies have found that mentorship can improve undergraduate research skills like critical thinking, problem solving, and communication. For example, Laursen et al. [50] discovered that undergraduate students with mentors reported higher research skills than those without. However, while the relationship seems straightforward, it is important to emphasize that the findings of several studies disagree on the relationship between mentorship and undergraduate research skills. For instance, Malcom and Feder [51] found that mentorship had little impact on the development of undergraduate research skills. This suggests that the relationship between undergraduate research and mentorship is complex and may be influenced by several factors, including

the quality of the mentorship, the student's prior research experience, and the specific research project. Thus, while some findings suggest that mentorship positively influences undergraduate research skills, there is still a need to investigate this relationship further to understand better the factors that influence the efficacy of mentorship and the specific strategies by which mentorship impacts undergraduate research skills. Exploring this relationship can be useful for promoting research skill development and assisting students in academic institutions achieve their research endeavors. With these, the following hypotheses are offered:

Hypothesis 1 (H1). *Mentoring positively and significantly affects students' information-seeking skills.*

Hypothesis 2 (H2). *Mentoring positively and significantly affects students' information-sharing behavior.*

Hypothesis 3 (H3). *Mentoring positively and significantly affects students' competency development.*

Hypothesis 4 (H4). *Mentoring positively and significantly affects students' research skills.*

2.3. Information-Seeking Skills and Research Skills

Students are often faced with challenges and difficulties throughout their university stay. In response, their help-seeking skills are considered a deliberate act of seeking assistance, guidance, or support [52–54]. Help-seeking among students involves actively seeking solutions from others to address their problems, acting proactively to avoid a potential failure, and enhancing independent learning, ultimately leading to improved academic achievement [55,56]. In many cases, help-seeking behavior involves information-seeking skills. For instance, when students seek help, they often require specific information to understand better and find appropriate solutions to address their needs more effectively. Chlomoudis et al. [27] observed that students seek information to fulfill their information requirements, which, in turn, enhances their academic or professional performance. Information need is an individual's recognition that their knowledge is inadequate to attain an objective, while information behaviors encompass all forms of intentional and unintentional information-seeking patterns [57,58]. Information literacy is identifying information needs, identifying and retrieving relevant information, and evaluating and using information effectively and efficiently [59]. Furthermore, information literacy is an individual's ability to identify the need for, search for, evaluate critically, and use the information to solve problems in diverse situations [60]. Research on information literacy is closely linked to the study of information-seeking behaviors. A considerable body of literature investigates how students seek information in the context of learning and information literacies (e.g., [60,61]). The advent of the internet has accelerated information seeking [62].

Accordingly, information literacy research focuses on expressing information-seeking skills and educational outcomes. Wilson [63] proposed a nested model that partitions information behavior research into distinct subfields. The primary field is information behavior, within which the study of information-seeking behavior examines individuals' diverse techniques to discover and obtain access to information sources. Within the broader domain of information-seeking behavior, information-searching behavior is a subset that concentrates specifically on the interactions between computer-based information systems and information users [64]. In an academic setting, seeking information is an essential component of the tasks given to the students. Students are expected to actively engage in the information-gathering process to draw conclusions based on information from various sources [65]. The critical characteristics of information seeking are the availability of various alternatives and the student's responsibility to find the required information. In a learning context, information behavior related to tasks is frequently imposed to elicit expected learning outcomes [65]. Howlader and Islam [66] revealed that most undergrad-

uate students require academic- and employment-related information. As a result, they frequently visit the library to perform research work and study for competitive job exams. According to Singh et al. [62], how undergraduates search for information within an academic environment involves searching for, assessing, choosing, and utilizing information for educational and academic objectives. Thus, information-seeking skills are an important aspect of the research process, and individuals with strong information-seeking skills are better equipped to conduct high-quality research. Students are expected to identify and find relevant information from various sources to conduct effective research. This necessitates information-seeking skills such as defining research questions, developing search strategies, evaluating sources for relevance and reliability, and synthesizing and analyzing information. Thus, we propose the following hypothesis:

Hypothesis 5 (H5). *Information-seeking skills positively and significantly affect students' research skills.*

2.4. Information-Sharing Behavior and Research Skills

Moore [28] defined information sharing as the exchange of relevant and timely information, both formally and informally, among participants (e.g., students). Bălău and Utz [67] argued that due to the proliferation of online collaborative platforms, it is essential to understand and effectively manage the dissemination of information in the present-day knowledge-based economy. Cho et al. [68] aimed to clarify the process of sharing information and to explore the internal and external motivators that may encourage individuals to share information on Facebook. Information-sharing behavior influences research skills by providing access to a broader range of ideas, perspectives, and resources. For example, when students share information, they can exchange knowledge, mutual learning, and collaborative efforts to achieve shared objectives. This facilitates the students in gaining fresh insights and diverse perspectives that can aid in refining their research questions, creating more robust research designs, and generating innovative and impactful findings. Thus, the following hypothesis becomes relevant.

Hypothesis 6 (H6). *Information-sharing behavior positively and significantly affects students' research skills.*

2.5. Competency Development and Research Skills

Competence is the ability of an individual to successfully handle certain situations or complete a specific task or job [29]. Adler [30] and Brown et al. [31] highlighted that the aspects of competency will change and become more rigorous due to several factors, such as globalization, the advent of novel production techniques, the extensive use of information technology, and the increasing significance of knowledge-based production in different organizations. Competency development integrates skills, knowledge, and job attitude to achieve the desired workplace behavior and performance [32]. Forrier and Sels [33] defined competency development as the actions undertaken by the employee and the organization to preserve or improve the employee's functional-, learning-, and career-related competencies. Competence development in organizations can be divided into two categories: formal learning, which is planned and organized with certification, and informal learning, which occurs regularly during work and everyday life with a low degree of planning and organizing. While formal learning is popular, informal learning occurs while primarily performing another task and is characterized by a lack of focus on learning [34,35]. Analogously in an academic setting, students' competence in carrying out undergraduate research projects stems from formal and informal learning, with a strong emphasis on the former. Universities design programs and allocate resources to develop students' skills in identifying critical research questions, seeking information sources,

designing research methods, synthesizing research findings, and disseminating project results. In addition, mentors and fellow students within and outside the institution help students gain competencies, including desired attitudes, in performing research tasks. On the other hand, students' access to the internet via video-sharing, e-learning, and even social networking platforms provides vast opportunities for increased research competencies. Thus, we propose the following hypothesis:

Hypothesis 7 (H7). *Competency development positively and significantly affects students' research skills.*

The proposed structural model and its hypothesized relationships are shown in Figure 1.

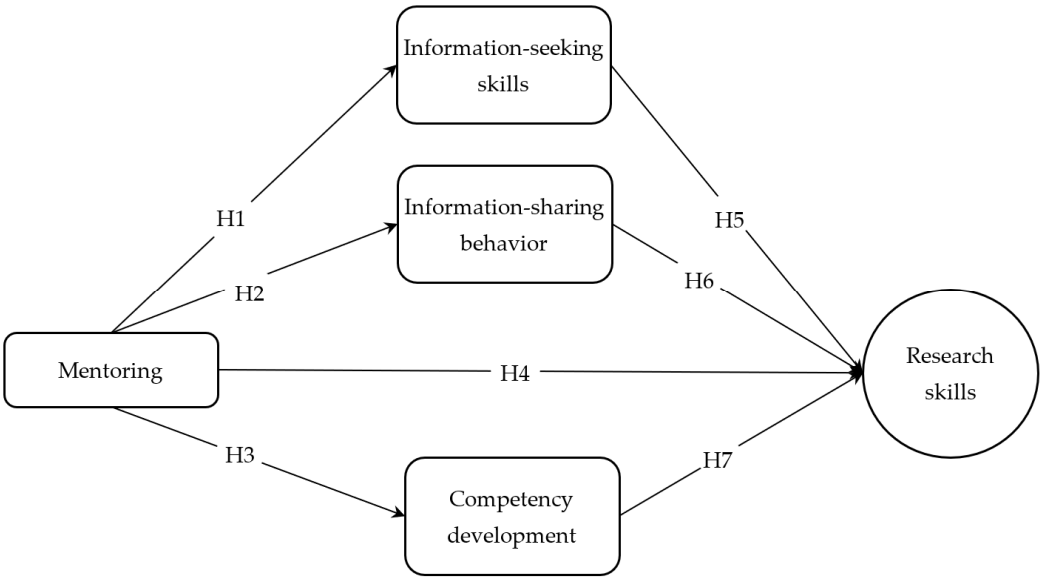

Figure 1. The proposed structural model.

3. Methods

3.1. Sampling and Data Collection

The measurement items for each construct in this work were adopted from validated measures generated from previous works, as summarized in Appendix A. Mentoring (MEN) construct has eight measurement indicators, competency development (CD) has seven measurement indicators, information-sharing behavior (ISB) construct has four measurement indicators, information-seeking skills (ISS) construct has three measurement indicators, and research skills (RS) construct has eight measurement indicators. The survey instrument was refined by academic experts, and the wording relevant to research skills was revised. Furthermore, the survey instrument measures all the constructs using a 7-point Likert scale with measurement items of all constructs ranging from 7 as "strongly agree" to 1 as "strongly disagree" and a qualifier question of "Have you taken any research course?". Also, a consent form was attached to the survey questionnaire to ensure that participants were adequately informed and gave consent to participate in the study on a voluntary basis. The consent form allows the participants to withdraw from answering the study at any time if they feel uncomfortable with the questions. This work utilized a random sampling technique. The survey instrument was translated to Google Forms for convenience, efficient administration, and cost efficiency. The survey questionnaire was personally administered by enumerators with smart devices and an internet connection and was only disseminated online for three weeks, from 3 March 2023 to 24 March 2023. The participants were undergraduate college students that have taken their research course (e.g., undergraduate thesis writing) in the Philippines. There were 610 responses collected. Thirty-seven did not provide consent to answer the survey, and thirty-four had non-engaging responses, which

were eliminated from the analysis. Of the 610, only 539 were valid and used for the final analysis. There was no missing data in the survey since all questions were required to have a response.

3.2. Profile of the Participants

The majority of the undergraduate student participants had an academic major in education (26%), engineering and technology (24%), and tourism and hospitality (16%), as presented in Figure 2. In this work, the undergraduate students were identified primarily as female (73%). Since a qualifier question was incorporated in the survey questionnaire, all participants completed a research course culminating in an undergraduate thesis project. They were prompted to think about their experience during their respective research classes and the mentor they had during the implementation of their undergraduate research project. In the case of most universities in the Philippines, undergraduate students are required to form a group of three to five members drawn from the same research class. Each group is supervised by a faculty member acting as an adviser who is considered their mentor in completing an undergraduate research project, a requirement for the course. It is noteworthy that advisers or mentors of these projects possess comparable qualifications, including holding a master's degree in the discipline they mentor. Also, faculty members in most Philippine universities obtained their undergraduate and graduate qualifications from nearby universities, with an estimated ratio of 1:100 faculty members obtaining their graduate studies abroad. This scenario demonstrates the homogeneity in the professional roles and qualifications of all mentors in undergraduate research projects.

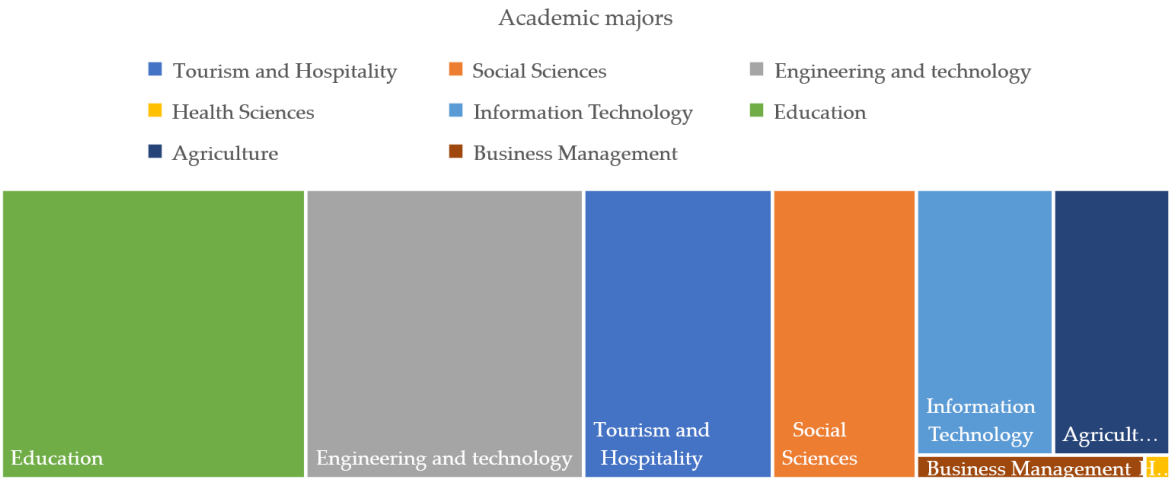

Figure 2. Academic major of the participants.

3.3. Data Analysis Results

Two structural equation modeling approaches are widely available: (1) Partial Least Squares–Structural Equation Modeling (PLS-SEM) and (2) Covariance-Based Structural Equation Modeling (CB-SEM). Specifically, PLS-SEM and CB-SEM differ in several aspects. First, in studies that aim at testing or confirming a theory, the appropriate method is CB-SEM, which focuses on the model fit, while PLS-SEM aims to maximize the covariance between latent variables for improved model interpretation [69,70]. Second, CB-SEM is restricted to reflective constructs, although some studies utilized formative measurements in the structural model leading to identification issues. In contrast, PLS-SEM can analyze research models that include both reflective and formative constructs, providing a more flexible approach [71,72]. Third, CB-SEM requires meeting assumptions related to data normality, independence, and uniformity, which can lead to inaccurate results if violated, while PLS-SEM is a more robust method for analyzing data with a non-normal distribution, using standardization techniques to align with the central limit theorem [70,73–75]. Finally, PLS-SEM can perform predictive analysis of dependent latent variables, while CB-SEM

overlooks the prediction goal of empirical research [70,76]. PLS-SEM is widely recognized as the optimal analytical tool for obtaining crucial information on the antecedents or drivers of a specific construct [77]. Thus, this work utilized PLS-SEM to establish logical criteria and assess the direct relationship between the exogenous and endogenous constructs. Furthermore, as discussed, PLS-SEM is a more robust and comprehensive statistical method for determining structural models in highly complex domains [78]. In the analysis, this study used the SmartPLS software version 4.0.8.5.

4. Results

4.1. Measurement Model Assessment

The parallel testing of the outer measurement model and the inner structural model, as well as the presence of both reflective and formative latent variables, is facilitated by PLS analysis [79]. Since the proposed model in this study includes reflective measures, the first criterion in evaluating the model is to examine the validity and reliability of the measures [80]. As per the assessment of the measurement model, all indicators are convergent and reliable, as shown in Table 1. Convergent validity examines how well individual items align within a construct and assesses the correlation between items measuring the same variable [81,82]. A construct is considered to have convergent validity when its Average Variance Extracted (AVE) value is at least 0.5 [83]. However, this study accepts a factor loading of 0.65 for each item. Those with an outer loading above 0.65 are regarded as acceptable, while those with a loading value of less than 0.65 are removed [71]. No measurement indicators are removed after calculations through the SmartPLS algorithm since all indicators reach the threshold value of 0.65. All constructs have the appropriate convergent validity ranging from 0.573 to 0.724. Reliability and validity testing is conducted using composite reliability (CR) aside from the traditional Cronbach's (α). CR is preferred in PLS-SEM as it considers varying indicator loadings and avoids underestimation issues associated with Cronbach's α [77]. Furthermore, the measurement items are all reliable, with all the constructs reaching above Cronbach's alpha (α) threshold value of 0.70, which is considered a reliable and acceptable index [84,85], and the composite reliability (CR) threshold value of 0.70 [80]. The Cronbach's alpha ranges from 0.808 to 0.911, while the CR values range from 0.810 to 0.944. These results indicate high-reliability values.

Table 1. Measurement model assessment results.

	Convergent Validity		**Construct Reliability**			**Convergent Validity**		**Construct Reliability**	
	Loading	**AVE**	**CR**	**α**		**Loading**	**α**	**CR**	**AVE**
CD1	0.770	0.653	0.912	0.911	MEN1	0.723	0.573	0.894	0.893
CD2	0.841				MEN2	0.762			
CD3	0.852				MEN3	0.758			
CD4	0.787				MEN4	0.793			
CD5	0.792				MEN5	0.773			
CD6	0.799				MEN6	0.730			
CD7	0.813				MEN7	0.768			
ISB1	0.809	0.639	0.81	0.808	MEN8	0.746			
ISB2	0.676				RS1	0.751	0.717	0.944	0.943
ISB3	0.856				RS2	0.847			
ISB4	0.844				RS3	0.870			
ISS1	0.810	0.724	0.818	0.810	RS4	0.894			
ISS2	0.869				RS5	0.879			
ISS3	0.872				RS6	0.847			
					RS7	0.841			
					RS8	0.839			

Note: α = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted; CD = competency development; ISB = information-sharing behavior; ISS = information-seeking skills; MEN = mentoring; RS = research skills.

The degree to which a construct is empirically distinct from other constructs is called discriminant validity. Fornell and Larcker's [83] criterion is a common method in assessing discriminant validity and typically reveals collinearity issues in the inner model. The AVE of the discriminant validity constructs is greater than the squared correlation of each latent variable [83]. The square roots of the AVE are bolded in Table 2, whereas non-bolded values represent the intercorrelation value between constructs. All off-diagonal values are less than the square roots of AVE, indicating that the Fornell and Larker condition is satisfied.

Table 2. Fornell and Larcker results.

	Competency Development	Information-Sharing Behavior	Information-Seeking Skills	Mentoring	Research Skills
Competency development	**0.808**				
Information-sharing behavior	0.409	**0.800**			
Information-seeking skills	0.421	0.507	**0.851**		
Mentoring	0.671	0.369	0.379	**0.757**	
Research skills	0.332	0.386	0.422	0.260	**0.847**

Note: Square root of AVE is shown on the diagonal of the matrix in bold; inter-construct correlation is shown off the diagonal.

The Standardized Root-Mean-Square Residual (SRMR) measures the average discrepancy between observed and expected correlations in a structural equation model. It provides an absolute assessment of model fit by indicating the magnitude of these discrepancies. A threshold value below 0.10 or 0.08 [86] generally indicates a good fit. Henseler et al. [87] introduced the SRMR as a useful goodness-of-fit measure in PLS-SEM, helping to identify and prevent model misspecification. In this study, the SRMR value is 0.054, lower than the threshold standard acceptable fit value of 0.08. The Normed Fit Index (NFI) is a metric used in PLS-SEM to assess the overall fit of the model to the data [88]. It compares the fit of the estimated model with that of a null or baseline model, considering the degrees of freedom. The NFI ranges from 0 to 1, with values closer to 1 indicating a better fit. It shows how accurately the model captures the observed covariances between the variables. In this work, the NFI value is 0.848, reflecting a moderate fit, an acceptable value. Thus, the research model fitness demonstrates an acceptable fit.

4.2. Structural Model Assessment

This work assesses the predictive power of the endogenous variables in the model [89]. The main criteria for evaluating the structural model using PLS-SEM are the strength of path coefficients, R^2 values (prediction power), and f^2 (effect size), as suggested by Hair et al. [80]. The coefficient of determination (R^2) measures the model's predictive accuracy. The combined influence of the exogenous variables on the endogenous variable(s) ranges from 0 to 1, with 1 corresponding to complete predictive accuracy. The acceptable R^2 of 0.75, 0.50, and 0.25 correspond, respectively, to substantial, moderate, and modest levels of prediction accuracy [72,74]. In this study, R^2 provides the predictive accuracy of the structural model, as shown in Figure 3. CD explains the highest variance with an R^2 value of 0.468 (46%). Furthermore, other constructs have a modest prediction accuracy, with RS, ISS, and ISB having R^2 of 0.255 (25%), 0.162 (16%), and 0.152 (15%), respectively. All of the hypotheses (H1, H2, H3, H5, H6, H7) are supported except for H4. These are summarized in Table 3 and visualized in Figure 3.

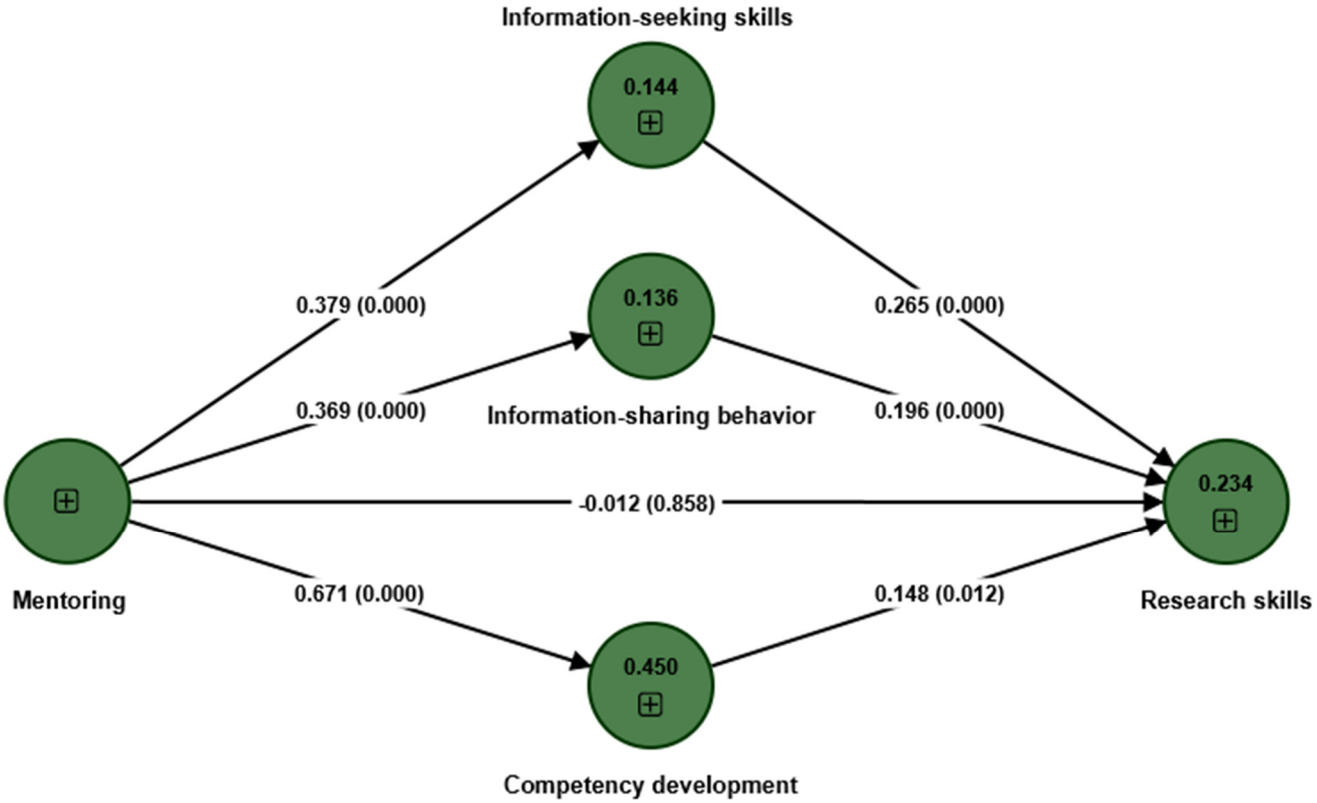

Figure 3. Structural model.

Table 3. Path coefficient results.

Hypotheses	β	t Values	*p* Values	Decision
H1: Mentoring → Information-seeking skills	0.379	8.363	0.000 ***	Supported
H2: Mentoring → Information-sharing behavior	0.369	9.672	0.000 ***	Supported
H3: Mentoring → Competency development	0.671	12.798	0.000 ***	Supported
H4: Mentoring → Research skills	−0.012	0.179	0.858 ^{ns}	Not Supported
H5: Information-seeking skills → Research skills	0.265	5.086	0.000 ***	Supported
H6: Information-sharing behavior → Research skills	0.196	3.556	0.000 ***	Supported
H7: Competency development → Research skills	0.148	2.514	0.012 **	Supported

Note: *** $p < 0.000$; ** $p < 0.001$; ns not significant.

The effect size, as defined by Cohen [90], Cohen [91], and Kock [92], represents the magnitude of an effect irrespective of the sample size being examined. Using the PLS algorithm, the effect size (f^2) values are estimated, indicating 0.02 (minor), 0.15 (medium), and 0.35 (substantial) effects on the relationship between exogenous and endogenous constructs [80]. Furthermore, a value less than 0.02 implies no effect of exogenous constructs on an endogenous construct. In this study, the f^2 results show that MEN has a substantial effect on CD ($f^2 = 0.818$). Moreover, MEN has a medium effect on ISB ($f^2 = 0.158$) and ISS ($f^2 = 0.168$). Both ISB and ISS have a medium effect on RS with ($f^2 = 0.035$) and ($f^2 = 0.062$), respectively. However, CD has a negligible effect on RS ($f^2 = 0.014$), and MEN has no effect on RS ($f^2 = 0.000$). These results are consistent with the other findings of the study.

4.3. Mediating Effect

The mediating relationships in the structural model are shown in Figure 3. In this work, the mediator analysis procedure in the PLS of Zhao et al. [93] is followed as Hair et al. [94] suggested for PLS-SEM. The result shows that information-seeking skills, information-

sharing behavior, and competency development fully mediate mentoring to students' research skills since H4 is not supported.

5. Discussion and Insights

Drawn from Bandura's social learning theory, this study examines the proposed structural model that highlights how undergraduate students' research skills are improved by mentoring initiatives of faculty researchers in an academic institution. In addition, it investigates the mediating roles of information-seeking skills, information-sharing behavior, and competency development in the relationship between mentoring and research skills. The proposed structural model finds its motivation from existing studies emphasizing the role of mentoring in offering guidance, support, and feedback to students along the research process [20,22]. Due to the compelling factors associated with mentoring, as espoused by Malcom and Feder [51], information literacy and competency development constructs are hypothesized to mediate the direct relationship between mentoring and research skills. Such an attempt reflects the components of social learning theory, which suggest that behaviors of individuals are not only shaped through observational learning (i.e., mentoring or role modeling) but also require cognitive processes that they deem to perform and the need for reciprocal determinism and feedback mechanisms. The limited insights in the domain literature require empirical evidence to support the design of initiatives to improve undergraduate students' research skills. Seven hypothesized paths are examined. The cross-sectional empirical analysis demonstrated in this work supports six of the seven hypotheses, leaving the direct path from mentoring to research skills unsupported.

The findings show that mentoring enhances the information-seeking skills of undergraduate students (H1), supporting the findings of Ransdell et al. [20]. An important component in the completion of the undergraduate research project, particularly in its initial phase (e.g., review of the extant literature), is the guidance of the mentor on how to search for references effectively (e.g., journal articles, conference papers, books) to build up the background of the project. This includes a critical understanding of the available platforms to search for these references, the quality of information present, and the amount of information necessary to build up the arguments that serve as the groundwork for the project. Over time, in a constant one-on-one interaction between the faculty mentor and student mentees, such skills are refined, the behavior is developed, and the seeking of information becomes more efficient. This view supports the social learning theory in a more straightforward manner in such a way that the information-seeking skills of mentees are driven by observational learning from their mentors. This relationship extends to the information-sharing behavior of students, supporting H2. With mentors possessing higher digital literacy for efficient collaboration and information sharing among peers via online platforms, the mentoring initiative facilitates knowledge transfer to students. Particularly in an undergraduate research project that comprises two or more students as member proponents, student mentees would find it more beneficial to gain those information-sharing skills from their mentors, such as the use of cloud storage and real-time collaboration platforms (e.g., Google Docs, Microsoft Teams, Slack, Asana, Trello, Zoom, Figma, Miro). With more relevance during the COVID-19 lockdowns, such tools have become imperative to support efficient communication among project members. Thus, as the study findings suggest, mentoring promotes undergraduate students' information literacy.

The role of mentoring in espousing competency development is also empirically supported in this study (H3). The most straightforward tasks of good mentors are ensuring that student mentees receive sufficient guidance, develop critical thinking, enhance their knowledge base of the discipline, receive helpful feedback, and promote creativity. These initiatives improve the necessary competencies pivotal in completing the research project. Since student mentees look up to mentors as role models, these competencies are honed during the mentoring process until the student's potential eclipses their mentors'. This finding also supports the core concept of observational learning and role modeling that

the social learning theory describes in shaping behaviors and skills. On the other hand, the hypothesized relationship between the information-seeking behavior and research skills (H5) of students is supported in this study. Those skills that can identify sources of information, evaluate the quality of information from these sources, and utilize this information to draw arguments augment several aspects of undergraduate research project implementation. These include (1) the use of bibliographic records; (2) the formulation of a scientific problem, research objectives, and research hypotheses; (3) the selection of the population, the sample, and appropriate type of sampling; (4) the selection, development, and application of methods, techniques, and instruments; and (5) the analysis and processing of information. Students who lack the behavior of seeking, organizing, and utilizing information would find it difficult to execute these aspects in the research process. Hence, a straightforward role of information-seeking behavior is deemed apparent in developing research skills. Our finding also suggests that the information-sharing behavior of students develops their research skills (H6). A plausible view of this relationship is the two-way effect that students experience during information sharing. When students share critical information they know, they always get feedback from their peers and even outside the institution. The feedback loop helps refine their knowledge, correct knowledge gaps, and eventually enhance the existing information they possess. The continuous feedback during information sharing promotes those research skills (i.e., searching for relevant sources, formulating the research questions, selecting the appropriate methodology, properly applying the methods, and analyzing the findings), interpreting the results, drawing conclusions, and writing the final report. On the other hand, the competency development of students also promotes their research skills (H7). Such a relationship is almost straightforward. Students who develop the competencies necessary for implementing research projects demonstrate their research skills more efficiently and effectively. These competencies form the baseline for students to carry out the skills needed to complete their projects. The findings of H5, H6, and H7 can be explained from the lens of social learning theory in the following manner. The presence of information literacy and competency development of undergraduate students reinforces their self-efficacy, which is a central concept in Bandura's social learning theory. As students gain knowledge (i.e., through information seeking and information sharing), skills, and competencies in carrying out a research project, their belief in their own abilities increases.

Finally, the most critical finding of this study is the unsupported relationship between mentoring and research skills (H5). This suggests that mentoring does not directly translate to developing the research skills of students, at least in carrying out their undergraduate research projects. In effect, mentoring can only develop those skills if students possess information-seeking skills and information-sharing behaviors and develop their required competencies, as implied in the full mediating roles of their constructs. This finding offers important insights. First, those role-modeling demonstrations in the form of sharing the history of the mentor's career, revealing personal experiences, and conveying respect have an insignificant impact on molding students' research skills. This implies that abstract motivational sharing could hardly translate to the actual development of students' research skills unless they enhance students' behaviors to seek and share information and promote competency development. Secondly, while mentoring allows the mentor to recommend specific strategies to accomplish the project and help finish certain assigned research tasks, without the information literacy and developed competence of students, it does not improve their research skills. This may be viewed as follows. For instance, the mentor may direct a student to implement a specific modeling methodology to analyze the causal relationships between variables in a research project. While such directives may complete the tasks at hand, when students' creativity to seek and share information and students' effort to consciously perform abstraction about the tasks to improve their competence are missing, they cannot replicate the use of such a methodology to understand another differently framed research question. Thus, mentors must not only focus on directing the mechanical aspects of doing the tasks associated with the method; instead, they must put emphasis on

shaping students' behaviors to think and figure out why such a method is necessary for a given problem and how to manipulate and extend the same method to address future research questions. Such behaviors demand greater information literacy and competence development. Third, while students receive opportunities to learn new skills during the mentoring process, these skills must be paired with the conscious effort to distill, interpret, and utilize information to translate those opportunities into developed research skills. These insights associated with the full mediation of information literacy and competence development between mentoring and research skills are deemed novel in the literature.

Furthermore, the insights of our empirical study espouse the social learning theory of Bandura [42] in the following areas. First, role modeling and mentoring (i.e., observational learning) shape certain skills that may require less sophistication, such as increasing information literacy and competency development. Information-seeking skills can be directly shaped by observational learning as the process of information seeking can be thought of as highly mechanical and procedural than cognitive. Similarly, individuals develop some aspects of competencies from their mentors as part of observational learning. Meanwhile, one aspect of mentoring forms reinforcement through rewards and punishments that individuals (or students) receive from their mentors, which enables them to imitate and perform those skills being rewarded. Also, the exchange process of sharing information among peers, as in the case of members in a project, supports one of the fundamental aspects of social learning theory known as reciprocal determinism [42]. It suggests that individuals do not only learn from their environment, but they also actively influence their environment through the information they learn from various sources, facilitating the social aspect of the theory. Second, in relation to the first, observational learning may not shape highly sophisticated skills. Like other complex skills, research skills require more dynamic cognitive skills that can distill, synthesize, and combine concepts in a creative fashion and are adaptive to changes in several factors related to study design, data and information processing, weather conditions, policy-driven nuances, and other environmental factors. Thus, characterizing specific skills primarily driven by observational learning becomes imperative. Third, enforcing self-efficacy in individuals to perform sophisticated skills can be highlighted as a direct implication of the full mediation effects of information literacy and competency development between mentoring and research skills. Emphasized as fundamental in social learning theory, self-efficacy influences whether an individual performs or imitates a specific skill or behavior. In our empirical work, observational learning through mentoring promotes information literacy and competency development, eventually enhancing self-efficacy. Increasing self-efficacy for highly sophisticated skills, such as carrying out research projects, is critical for augmenting those skills. Thus, observational learning and role modeling must be designed to increase self-efficacy in complex tasks.

6. Concluding Remarks

6.1. Summary

This work proposes and validates an empirical model motivated by the social learning theory that explains the development of research skills of undergraduate students. Due to the multiple stages associated with undergraduate research projects, mentoring between faculty researchers and students within the same or different institutions becomes apparent. While the current literature offers empirical support linking mentoring and general research skills, specifically exploring undergraduate students' research skills is limited. Such an agenda may not be straightforward, as these students typically face research tasks for the first time. Thus, the proposed structural model espouses the possible mediating role of information-seeking skills, information-sharing behavior, and competency development in the relationship between mentoring and research skills. The model proposes seven hypothesized paths, and 539 valid participants are used to test these paths via PLS-SEM. All hypotheses are supported, except for the direct link between mentoring and research skills, implying that information literacy constructs and the competency development of students fully mediate such a relationship.

6.2. Implications

The findings of this study show three critical contributions. First, mentoring positively supports information-seeking skills, information-sharing behaviors, and competency development, partially supporting others in the literature. This implies that the technical guidance of the mentor on continuous one-on-one interaction with the student mentee refines the student's behavior in critically seeking information, assessing its quality, and creatively utilizing such information to build arguments for the research project, contest theories, and identify appropriate methodologies. On a similar note, mentors possessing high digital skills can transfer knowledge to students by sharing information to achieve collective success for the project, especially for undergraduate students who typically work in teams. The path from mentoring to competency development offers direct evidence regarding how mentors shape the required competencies of students to carry out research tasks. Secondly, the paths from information literacy and competency development constructs to research skills are positively supported in this study. This finding suggests that students who seek information and share it with peers or team members improve their research skills in accessing relevant sources, establishing research questions, evaluating appropriate methods, implementing those methods, interpreting findings, drawing relevant conclusions, and writing reports. In particular, the feedback loops in information sharing promote the development of the required research skills in completing projects. Finally, our findings demonstrate the full mediation effects of information literacy constructs and competency development, opposing the direct link of mentoring to research skills. This novel empirical support highlights the need for mentors to shape students' information-seeking and information-sharing behaviors to effectively translate mentoring efforts to developing hard research skills. They must focus beyond the mechanical aspects of performing the tasks to espousing students' creativity to consciously perform abstractions to address future research questions that may be framed differently. Such an initiative requires students to develop information-seeking and sharing behaviors, along with training that enhances their competencies.

6.3. Limitations and Future Work

Although these findings are pivotal in the literature, some limitations are evident. First, the participants in this study are from the Philippines, with inherent cultural and political makeups. Future work may expand our empirical model to a multi-cultural investigation with more participants. A multi-group analysis in PLS-SEM may identify the differences brought about by these varying cultural biases. Secondly, the participants belong to institutions with heterogeneous academic reputations. Some of them came from top-ranked universities with excellent faculty resources. In effect, the quality of the mentorship programs present in these universities may be significantly different from those in the lower-ranking quartiles. Thus, future studies may look into the technical competence of mentors as a moderating variable in developing research skills. Finally, predictive machine learning algorithms based on several factors leading to improving research skills may be interesting for future work.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Measurement indicators.

Constructs	Indicators	References
Mentoring (MEN)	MEN1. My mentor shares the history of his/her career with me. MEN2. My mentor discusses my questions regarding feelings of competence and commitment to advancement. MEN3. My mentor shares personal experiences as an alternative perspective on my problems. MEN4. My mentor suggests specific strategies for accomplishing work objectives. MEN5. My mentor gives me assignments that present opportunities to learn new skills. MEN6. My mentor helps me to finish assignments. MEN7. My mentor conveys feelings of respect for me as an individual. MEN8. I respect and admire my mentor.	Younas and Bari [95]
Competency development (CD)	CD1. A more experienced mentor who guides me in my research and from whose experience I can learn. CD2. My adviser ensures I learn about the research by giving me challenging assignments. CD3. My adviser makes sure that I develop the competencies that I need for my research career. CD4. In my organization, training sessions are organized to gain knowledge. CD5. My adviser regularly gives me feedback about my performance. CD6. I can make use of personal development plans to know what competencies I need to develop. CD7. I have been given tasks that develop my competencies for the future.	Younas and Bari [95]

Table A1. *Cont.*

Constructs	Indicators	References
Information-seeking skills (ISS)	ISS1. I can use a variety of available options to search for information that my colleagues are not aware of. 1SS2. I can inform my classmates of different ways to effectively search for information. 1SS3. I can generate keywords to search for information for academic work.	Hong and Kim [96]
Information-sharing behavior (ISB)	ISB1. I can interact with classmates using real-time communication tools, for example, video conferencing tools or messengers. ISB2. I can share my opinions online, for example, with blogs, social networking services, or web pages. ISB3. I can share my files with classmates using online software. ISB4. I can collaborate with classmates using online software.	Hong and Kim [96]
Research skills (RS)	RS1. Use of catalogs, descriptor books and bibliographic records. RS2. Relation to the formulation of a scientific problem, research objectives, and research hypotheses. RS3. Selection of the population, the sample, and the type of sampling to be used. RS4. Selection, development, and application of methods, techniques, and instruments. RS5. Analysis and processing of information through different statistical techniques. RS6. Interpretation and discussion of results are presented in tables and graphs. RS7. Drawing up conclusions and recommendations. RS8. Writing final research reports.	Ipanaqué-Zapata et al. [97]

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