



Article

Bridging Science and Society: Socio-Scientific Competencies and Training Needs of Future Educators in Bulacan, Philippines

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Abstract

This study assessed the socio-scientific teaching competencies and training needs of future science educators at Bulacan State University. Using a quantitative approach, 3rd- and 4th-year BSEd Science major students participated through a validated survey adapted from Khatoon, Alam, and Bukhari (2014). The instrument measured self-perceived competencies in five areas: lesson planning and preparation, delivery and presentation, use of comparison and abstraction, formulation of generalizations, and application of lessons. Demographic factors such as age, residence, and family income were also considered.

Findings revealed that respondents were very competent in lesson planning and preparation, and competent in delivery and presentation, comparison and abstraction, generalization, and application. A significant difference emerged by age, with older respondents showing higher competencies, while younger ones reported relatively lower levels. No significant differences were found across residence and family monthly income.

The top five training needs identified were design thinking in science, authentic assessment, formative and summative assessment, integration of technology in science instruction, and contextual approaches in science instruction. These results underscore the importance of continuous professional development programs that integrate socio-scientific issues into teacher preparation curricula. Age-tailored trainings, hands-on workshops, and equitable access to professional development are recommended to enhance competencies and address generational gaps in delivering science lessons.

Keywords: *Bulacan State University, Future Science Educators, Socio-scientific Teaching Competencies, Training Needs*

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Introduction

Science classrooms today are expected to go beyond teaching facts and concepts. They must also help students understand and respond to real-world socio-scientific issues (SSI) such as environmental awareness, climate change, gene editing, and pandemic responses. Studies show that teaching with socio-scientific issues improves students' scientific literacy, critical thinking, community engagement, argumentation, flexibility, and civic reasoning because it connects science to social and ethical concerns that matter in everyday life (Sadler, 2009; Zeidler & Nichols, 2009; Hernández-Ramos et al., 2021; MDPI, 2024).

In the Philippine context, there is a growing recognition of the importance of equipping educators to implement socio-scientific issues (SSI) approaches effectively. A 2023 needs assessment among Filipino science teachers found that over 50% were highly aware of SSI-based teaching, recognized its necessity in their classrooms, and expressed willingness to participate in seminars and trainings and develop SSI-related materials, highlighting an apparent demand for professional development in this area. Socio-scientific knowledge can bridge the gaps between science education and societal relevance, prioritizing authentic, disciplinary, mastery, and context-sensitive pedagogies. (Badeo, Duque, & Arnaldo, 2024).

In the Philippines, persistent performance gaps in international assessments underscore the urgency of powerful, contextualized science teaching. In PISA 2022, Filipino 15-year-olds again scored below the OECD average in science, highlighting the need for approaches that connect disciplinary ideas to real-world decision-making (OECD, 2023). Implementing the K-12 basic education program does not bode well for science education. To achieve the institution's mission and goals, the key point to improve the higher educational system and science instruction is to assess the competencies, needs, challenges, and reform the instruction of science education (Hallinan, 2004) and provide the training needed by science educators. At the same time, the K to 12 Science Curriculum explicitly aspires to scientific literacy through integration, thinking process, problem solving, and application to daily life principles that align closely with socio-scientific issues pedagogy (Department of Education, 2016).

Science classrooms today are expected to do more than teach facts. They need to help students deal with socio-scientific issues (SSI), real problems where science bridges with ethics, policy, technology, and daily life.

This study, *"Bridging Science and Society: Socio-Scientific Teaching Competencies and Training Needs of Future Educators in Bulacan, Philippines,"* investigates how well future science educators are prepared to enact socio-scientific issues aligned to science

instruction and where capacity-building and training are most needed. By identifying strengths and areas for improvement in preparing and planning the lessons, delivery and presentation of lessons, using comparison and abstraction, formulating generalization, and application of the lessons, the study will help to enhance the effectiveness and socio-scientific competencies of future science educators in their delivery of science lessons. Training priorities will be directed to inform program design, practicum support, and continuous professional development pathways that can translate science learning into informed, responsible participation in society. The results will guide curriculum developers, policymakers, and teacher educators in designing responsive programs that prepare future educators to advance science education locally and globally.

Methodology

This study examined the socio-scientific teaching competencies of future science educators at Bulacan State University. It determined their corresponding training needs to strengthen the integration of social and scientific dimensions in classroom instruction. Employing a descriptive quantitative method, the research systematically captured comprehensive insights, ensuring efficient data collection and reliable interpretation of findings to enhance science lessons' social and scientific delivery.

Population and Sampling Design

This study employed a quantitative research design to objectively assess future science educators' socio-scientific teaching competencies and identify their training needs. A quantitative approach was considered appropriate as it allows the collection of measurable data and statistical analysis to establish patterns, precision, and reliability in the findings (Creswell & Creswell, 2018).

Cochran's formula was applied to determine the appropriate sample size. This formula is widely recognized as a standard method for calculating statistically representative samples, especially when dealing with large populations, because it minimizes sampling error and ensures that results achieve a desired level of confidence and precision (Israel, 1992). Using this computation, 143 third- and fourth-year BSEd Science major students from different campuses of Bulacan State University offering the BSEd Science program were identified as respondents.

Research Instrument

The researcher adapted and enhanced a questionnaire from Khatoon, Alam, Bukhari, and Mushtaq (2014), enriching it with expert-validated items tailored to measure future science educators' socio-scientific teaching competencies and identify their corresponding training needs. Expert validation of external reviewers -science and professional education specialists assessed the relevance, clarity, and alignment of items used in this research instrument. This process aligns with best practices in instrument validation used in recent educational research (Guo, Shi, & Zhai, 2024). Reliability was likewise established through pilot testing, resulting in consistent responses that confirmed the instrument's dependability for use in the present study. The finalized instrument comprised 37 items that evaluated self-perceived competence across essential areas of science instruction: preparing and planning the lessons, delivery and presentation of lessons, use of comparison and abstraction, formulating generalization, and application of the lessons. Responses were recorded on a five-point Likert scale, ranging from 5, described as very competent, to 1, described as incompetent. (Joshi, Kale, Chandel, & Pal, 2015).

Training needs were initially identified through interviews with science professors from Bulacan State University–Bustos Campus to strengthen the instrument's relevance. These needs were critical in addressing gaps, challenges, and areas of limited competence in science teaching. An open-ended section was also incorporated, allowing respondents to suggest additional training areas they considered vital for enhancing teaching effectiveness across diverse science disciplines (Cohen, Manion, & Morrison, 2018).

In addition to competencies and training needs, the study considered demographic variables such as age, area of residence, and family monthly income, providing a deeper understanding of the contexts shaping the respondents' teaching preparedness and professional development requirements. Prior studies emphasized that demographic and socioeconomic factors can significantly influence teacher competence, resource access, and professional growth (Darling-Hammond, 2017; OECD, 2019).

Data Collection and Analysis

The survey instrument was utilized and administered via Google Forms for accessibility and efficiency. The instrument was adapted from Khatoon, Alam, Bukhari, and Mushtaq (2014), whose work has been validated in prior studies on teaching competencies. It was chosen because of its alignment with the study's aim to evaluate both the scientific knowledge and the social dimensions of teaching practices.

Through the procedures provided, the study ensured that the collected data were both valid and reliable, providing a sound basis for assessing the socio-scientific teaching competencies of the respondents and identifying specific areas that require enhancement for their professional preparation.

The data collected in socio-scientific teaching competencies of future science educators were analyzed using frequency counts and mean scores based on a 5-point Likert scale, as presented in Table 1.

Table 1. Level of Socio-Scientific Training Competencies of Future Educators

Scale	Range	Description
5	4.21- 5.00	Very competent
4	3.41- 4.20	Competent
3	2.61-3.40	Moderately Competent
2	1.81- 2.60	Less Competent
1	1.0-1.80	Incompetent

Future educators' training needs were described in frequency and rank.

A one-way analysis of variance (ANOVA) was utilized to compare the means of more than two independent groups and determine significant differences. In this study, ANOVA was applied to examine whether respondents' age, area of residence, and monthly family income were significantly associated with future science educators' social and scientific teaching competencies.

Results/Findings

Competency means specific skills required for effectively teaching science subjects with different activities inside and outside the classroom to produce students' problem-solving ability and critical thinking (Khatoon, Alam, Bukhari, and Mushtaq, 2014). The teacher is an essential factor for students' learning in the classroom. Hence, it is important to identify and analyze the characteristics and competence of teachers (i.e., knowledge, attitudes, and beliefs) crucial for effective teaching and learning of students. The teaching competencies of teachers and future teachers, particularly in science, should provide learning opportunities and skills for the students. They should use different strategies, methodologies, and techniques that stimulate the development of the students' higher-order thinking skills (HOTS), such as critical thinking, like analyzing, synthesizing, and evaluating information (Watson, 2025).

The socio-scientific teaching competencies of future science educators were measured using very competent, competent, moderately competent, less competent, and incompetent scales.

Table 2. Descriptive Statistics on Planning and Preparation of Lessons for Future Science Educators

ITEMS	MEAN	VERBAL INTERPRETATION
1. Skill in motivating and arousing curiosity in students	4.03	Competent
2. Link the lesson with past personal/ social experiences	4.41	Very Competent
3. Define the problem (topic) in simple language.	4.32	Very Competent
4. Use multiple-choice questions.	4.42	Very Competent
5. Preparing activities that address both scientific understanding and real-world application.	4.15	Competent
6. Preparing PowerPoint presentations relevant to science content and community issues.	4.73	Very Competent
Weighted Mean	4.34	Very Competent

Table 2 revealed that in Planning and Preparing the Lessons, the socio-scientific teaching competencies of future science educators at Bulacan State University gained a mean score of 4.34 and were described as “very competent”. The highest mean of 4.73 was assessed among students in preparing a point presentation on science content and community issues. In contrast, the lowest mean of 4.03 was described as competent in their skills in motivating and arousing the students’ curiosity in science lessons.

Motivation is a significant factor for future science educators to actively engage the students in a more impactful discussion in the classroom. It will lead to the academic success of the students. The big challenge here is motivating the students to cope with the new system, learn, and succeed independently, which is critical to their academic performance and overall success. (Capunitan, Gregana & Lirado,2023).

Teaching methods must be engaging, diversified, and connected to students’ everyday lives to increase student motivation. Teaching and learning must occur in a supportive learning environment where students are encouraged to communicate their understanding of the tasks and where their ideas are valued and appreciated.

Future educators should enhance their skills in motivating and arousing curiosity among students. They should support students’ self-curiosity, self-efficacy,

and enjoyment of the subject as they discuss and share their understanding with peers, thus encouraging them to communicate their ideas, insights, and values.

Table 3. Descriptive Statistics on the Delivery and Presentation of Lessons of Future Science Educators

ITEMS	MEAN	VERBAL INTERPRETATION
1. Make a hypothesis for the presentation of the problem	4.01	Competent
2. Accept the incorrect answer of students during class discussion.	4.00	Competent
3. Use of computers.	4.34	Very Competent
4. Prepare research article for class discussion (science-related /community-based articles).	3.75	Competent
5. Discuss daily life examples (personal or community-based examples).	4.60	Very Competent
6. Integrate real-world examples in the lesson, including community and national issues.	4.55	Very Competent
7. Take pauses during presentation.	4.11	Competent
8. Arrange educational trips for finding answers to students' queries.	3.71	Competent
9. Preparing science models.	4.10	Competent
10. Use of multimedia and visual aids to enhance lesson clarity.	4.55	Very Competent
11. Use of laboratory equipment.	4.22	Very Competent
12. Competent in exemplification skills.	4.05	Competent
13. Arouse the interest of students during discussion.	4.24	Very Competent
Weighted Mean	4.17	Competent

Table 3 showed the mean score of 4.17 in the Delivery and Presentation of Lessons and was described as "competent". The highest mean score of 4.60 was obtained in the Use of daily life examples in discussion (personal or community-based examples). Using real-life and community-based examples in teaching makes learning more meaningful and impactful, as it helps students connect and communicate abstract concepts to their own personal and social experiences and environment (Darling-Hammond et al., 2020).

The lowest mean score of 3.71 was obtained for arranging educational trips to find answers to students' queries. Educational field trips are valuable extensions of classroom learning as they expose students to real-world environments where they can directly explore concepts, answer their queries, and make lessons more meaningful, relevant, and connect lessons to lived experiences. It also provides

authentic learning experiences among students that satisfy their curiosity and help them find answers to their questions through direct engagement. (Department of Education, 2001). (Behrendt & Franklin, 2014). DepEd Order No. 56 (2001) explicitly states that educational field trips can supplement classroom instruction by visiting places of cultural, historical, and scientific interest, such as museums, planetariums, zoological and botanical gardens, shrines, and scientific centers. However, there are challenges in organizing educational trips, such as financial constraints, safety concerns, and time management, that can limit the accessibility of educational trips despite the recognized benefits for the students. (Behrendt & Franklin, 2014)

Table 4. Descriptive Statistics on the Use of Comparison and Abstraction of Future Science Educators

ITEMS	MEAN	VERBAL INTERPRETATION
1. Make a student group to structure the problem and identify similarities and differences between scientific phenomena and social issues.	4.29	Very Competent
2. Collect information from the library	3.51	Competent
3. Use of the Internet to gather information for students	4.56	Very Competent
4. Link the concrete and abstract experiences of students	4.28	Very Competent
5. Help students organize and compare materials in tables, scientific concepts with real-life scenarios.	4.32	Very Competent
6. Guiding students in proposing solutions to challenges faced during real-world problem/issues investigations.	4.21	Very Competent
Weighted Mean	4.20	Competent

The competencies of future science educators in using Comparison and Abstraction in the delivery of science lessons got the mean score of 4.20, described as “competent”. The highest mean score of 4.56 was obtained from using the internet to gather student information. Using the internet as a learning tool enables students to access a vast range of updated information, develop research skills, and engage in self-directed learning. It promotes independent inquiry and critical thinking by allowing learners to gather relevant knowledge beyond textbooks and classroom discussions (Anderson & Rainie, 2018; Lorenzo, 2016).

Collecting information from the library revealed the lowest mean score of 3.51. The library is the heart and the source of any learning institution. It is a collaboration of people, hardware, and software whose purpose is to assist clients in using knowledge and technology to transform and improve their lives. Collecting information from traditional libraries is less in demand today because of the

widespread availability of digital resources and the internet. Online platforms provide faster, more convenient, and up-to-date access to information compared to printed materials. Students now rely heavily on electronic databases, e-books, and open-access journals that can be accessed anytime and anywhere. Moreover, the rise of ICT integration in education has shifted research practices toward digital literacy rather than traditional library dependency (Lorenzo, 2016; Tenopir et al., 2015).

Table 5. Descriptive Statistics of Future Science Educators in Formulating Generalizations

ITEMS	MEAN	VERBAL INTERPRETATION
1. Assign a task to conclude the main points about the topic.	4.41	Very Competent
2. Guide students in summarizing and synthesizing the scientific findings of the lesson/ experiment and linking them to social, environmental, or ethical implications.	4.24	Very Competent
3. Engage students in data collection/ field activities that examine local materials under study.	3.73	Competent
4. Ask questions to evaluate science topics' societal and ethical impacts.	4.59	Very Competent
5. Assist students in designing and writing research on science and community-based issues and challenges.	3.90	Competent
6. Competent in lesson closure, emphasizing scientific knowledge and its applications to real-life societal problems.	4.33	Very Competent
Weighted Mean	4.20	Competent

Table 5 revealed that the future science educators were “competent” in formulating generalizations, as shown by the mean score of 4.20. The highest mean score of 4.59 was shown when asking questions to evaluate science topics’ societal and ethical impacts. The teachers believe asking thought-provoking questions and using daily examples could prompt students to learn and develop critical thinking.

Engage students in data collection/ field activities that examine local materials under study, which showed the lowest mean result of 3.73. These activities help students move beyond rote memorization, fostering critical thinking, cultural empathy, personal growth, and community connection. Gadaza, Manera, et.al (2025) explored how embedding cultural heritage, such as indigenous knowledge, oral traditions, and historical narratives in teacher education curricula enables students to move beyond abstract learning. It highlights that curricular localization and community-based resources foster transformative learning experiences, cultivating educators’ identity, deeper student engagement, cultural empathy, and fostering connections between theory and lived experience. By integrating data collection and

field activities that explore local cultural, historical, or religious resources, future educators can offer students a transformative learning experience.

Table 6. Descriptive Statistics of the Socio-Scientific Competencies of Future Science Educators in the Application of the Lesson

ITEMS	MEAN	VERBAL INTERPRETATION
1. Guide students in making science models representing real-world environmental or societal systems.	4.34	Very Competent
2. Make a greenhouse effect or scientific simulations exploring human environmental impacts.	3.87	Competent
3. Create a new science thing related to social issues on charts.	3.99	Competent
4. Make an ecosystem in the school grounds	4.01	Competent
5. Make a botanical garden in school	3.85	Competent
6. Help students to design activities where scientific knowledge can be applied to solve real-world problems.	4.48	Very Competent
Weighted Mean	4.09	Competent

The socio-scientific competencies of future science educators in the Application of the Lessons were revealed in Table 6, with a mean score of 4.09 and described as “competent”. The highest mean score of 4.48 was obtained for the item, helping students design activities where scientific knowledge can be applied to solve real-world problems.

The lowest mean score of 3.85, described as competent, was assessed in making a botanical garden in the school. In their study, Mohamed, N., & Othman, N. (2021) examined the educational potential of a botanical garden as a learning environment. Suppose the educators can enhance their competencies in making well-designed and manage botanical gardens among students. In that case, gardens serve as “*windows of knowledge*”, enhance cognitive skills, and function as successful educational learning environments by offering students experiential, hands-on learning opportunities.

Table 7. Descriptive Statistics of the Socio-Scientific Teaching Competencies of Future Science Educators at Bulacan State University

SOCIO-SCIENTIFIC TEACHING COMPETENCIES	MEAN	VERBAL INTERPRETATION
Planning and Preparing Lessons	4.34	Very Competent
Delivery and Presentation of Lessons	4.17	Competent

Use of Comparison and Abstraction	4.20	Competent
Formulation of Generalization	4.20	Competent
Application of the Lesson	4.09	Competent
Weighted Mean	4.20	Competent

The grand mean of 4.20 for the socio-scientific teaching competencies of future science educators in their delivery of science subjects was described as “competent”.

The qualifications of its faculty greatly measure the standard or quality of an instruction or program. In this light, the faculty should be composed of competent members in terms of academic qualifications, experience, and professional expertise (AACUP, Inc. 2014).

Teaching competencies play a vital role in shaping students’ scientific literacy, which involves applying scientific knowledge to real-world issues and making informed decisions. Recent studies highlight that teacher competencies significantly influence students’ academic performance and ability to connect science with societal issues (Sangcap & Tindowen, 2024). Moreover, research in the Philippines shows that integrating socio-scientific issues into science lessons depends heavily on teachers’ preparedness, knowledge, and competencies, promoting scientific literacy and civic responsibility (Manalo, 2023).

Future science educators need to be competent since they will become teachers in the future who should demonstrate strong pedagogical, content, and socio-scientific skills, creating learning environments that foster critical thinking, problem-solving, and meaningful engagement with science. They need to be competent to relearn and equip themselves with the digital tools to meet the learning preferences of 21st-century learners. They must equip and capacitate themselves in the fundamental skills needed to respond to the demands of Industry 4.0 and Education 4.0, where technology integration, digital literacy, and adaptive teaching strategies are essential for preparing students for future societal and workforce challenges (Sá & Serpa, 2023; UNESCO, 2023).

Table 8. 2: Significant difference among future science educators with respect to age

			Sum of Squares	df	Mean Square	F	Sig.
Socio Scientific Competencies	Between Groups	(Combined)	5.258	10	.526	2.140	.026
	Within Groups		32.430	132	.246		

Mean * Age	Total	37.688	142
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The results show that age significantly affects socio-scientific teaching competencies, $F(10,132) = 2.14, p = .026$. Younger respondents (ages 18–19) had lower mean scores than the overall average, while socio-scientific competencies generally increased among those aged 20–24. The highest scores were observed in older respondents, though some had petite sample sizes. The findings suggest that teaching competencies tend to improve with age, likely due to greater maturity and experience. In addition, Casey, Tottenham, Liston, and Durston (2005) stated in their paper that cognitive and developmental growth of individuals continues into the early 20s, so 18–19-year-olds typically perform at lower levels on higher-order competencies. Educational and experiential exposure for ages 20–24 helps bolster mean socio-scientific competency scores, and older respondents, though few, may show the highest mean scores, given further maturity and experience. However, interpretation should be cautious due to potentially small sample sizes.

Table 9. Significant difference among future Science Educators with respect to Area of Residence

		Sum of Squares	df	Mean Square	F	Sig.
Socio-Scientific Teaching Competencies Mean	Between Groups (Combined)	.142	1	.142	.535	.466
	Within Groups	37.545	141	.266		
	Total	37.688	142			

* Area of Residency

The results indicate that socio-scientific teaching competencies do not significantly differ based on area of residency, $F(1,141) = 0.535, p = .466$. Although respondents from rural areas ($M = 4.25$) scored slightly higher than those from urban areas ($M = 4.19$), the difference is slight and not statistically significant. It suggests that the area of residency does not play a significant role in influencing socio-scientific teaching competencies, as both rural and urban respondents demonstrated comparable levels of competency.

Table 10. Significant difference among future Science Educators with respect to Family Monthly Income

		Sum of Squares	df	Mean Square	F	Sig.
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Socio-Scientific Teaching Competencies Mean *	Between Groups	(Combined)	1.475	7	.211	.785	.601
Family Monthly Income Bracket	Within Groups		36.213	135	.268		
	Total		37.688	142			

The analysis shows no significant difference in socio-scientific teaching competencies when grouped according to family monthly income, $F(7,135) = 0.785$, $p = .601$. While slight variations in mean scores exist, such as the highest score for the lone respondent in the “Above ₱100,000” bracket ($M = 4.81$) and the lowest for those in the “₱20,001–₱30,000” group ($M = 4.12$), these differences are not statistically meaningful. The results suggest that family monthly income does not significantly influence socio-scientific teaching competencies, as respondents across different income brackets demonstrated relatively similar competency levels.

Table 11. Training Needs of Future Science Educators based on their assessed Socio-Scientific Competencies

SCIENCE INSTRUCTION TRAINING	RANK
Design Thinking in Science	1
Science Authentic Assessment	2
Formative and Summative Assessments	3.5
Integration of Technology in Science Instruction	3.5
Contextual Approach in Science Instruction	5
Creating science models and Visual Aids	6
Trends in the use of scientific equipment and apparatus	7
Protocol/ Standards in using live animals/insects for experiments	8.5
Science Teaching Methodologies	8.5
Contextualization of laboratory activities in science	10
Handling science specimens for laboratory activities using microscopes	11
Utilization of laboratory equipment and apparatus in science	12
Multimedia approach in teaching Science	13
Understanding Scientific Concepts	14

Teachers are expected to be active agents of educational reform. To fulfill this role, they must be continually assessed, trained, and empowered through professional development initiatives that expand their perspectives on science education. Equally important, teachers should be supported in engaging in reflective practice, thinking critically about what they are doing, and exploring alternative approaches to teaching and learning (Priestley, Biesta, & Robinson, 2015; Kelchtermans, 2022; Park & Sung, 2013; Pantić, 2015).

Through training and professional development programs, an educator and future educator will be able to know the difficulties and challenges students face, the misconceptions they develop, and know how to tap prior knowledge while presenting new ideas, so students can build new and correct understandings, and help the students resolve the common misconceptions. This deepening of pedagogical content knowledge (PCK) equips teachers to tap into students' prior knowledge effectively, facilitating the construction of new, accurate understanding, and enabling them to address misconceptions constructively. PCK, as defined by Shulman (1987), refers to the fusion of subject-matter knowledge with pedagogical know-how tailored to how students learn a specific topic, including their misconceptions and preconceptions. The depth of PCK and the training that cultivates it constitute a robust knowledge base. It forms a cognitive roadmap that guides assignment design and progress monitoring. It also supports responsive questioning in the classroom and assignments to students to gauge student progress and support the questions students ask.

Developing the socio-scientific teaching competencies of future science educators requires a multi-dimensional approach to teacher preparation and ongoing professional development. It entails building content clarity to ensure accurate and meaningful integration of science concepts into socio-scientific contexts, enhancing pedagogical expertise for inquiry-based and issue-driven instruction, cultivating reflective practice to evaluate classroom decisions critically, advancing technological integration to engage 21st-century learners, and fostering collaborative, sustained learning communities that support continuous growth. Such a holistic model equips future educators to handle the complexity of socio-scientific issues in science teaching, while promoting both scientific literacy and responsible citizenship (Baran et al., 2024; Davis et al., 2025; Herro et al., 2023; Kim et al., 2024; Liu et al., 2024).

Conclusion

This study assessed the socio-scientific teaching competencies of future science educators at Bulacan State University, Philippines. Findings revealed that the respondents were very competent in planning and preparing science lessons, lesson delivery and presentation, comparison and abstraction, formulation of generalizations, and application of lessons.

A significant difference was found in socio-scientific teaching competencies of future science educators when grouped according to age. Older respondents demonstrated higher competencies, while younger respondents exhibited comparatively lower competencies. In contrast, no significant differences were

observed when respondents were grouped according to residence (urban or rural) and family monthly income.

Based on their identified training needs, the top five (5) areas for professional development were:

1. Design Thinking in Science
2. Science Authentic Assessment
3. Formative and Summative Assessment
4. Integration of Technology in Science Instruction and
5. Contextual Approach in Science Instruction

Considering these findings, it is recommended that socio-scientific issues be integrated into the curriculum of future educator courses to strengthen competencies in applying science to real-world contexts. It is suggested that organizing seminars and workshops focusing on Design Thinking in Science, Science Authentic Assessment, Formative & Summative Assessment, Integration of Technology in Science Instruction, and Contextual Approach in Science instruction be facilitated. Incorporate hands-on training and simulations to practice and apply the methods in a real classroom. The provision of age-tailored training to address specific competency gaps and ensure younger educators gain confidence in the essential areas of science instruction is also recommended.

References

- [1] Accrediting Agency of Chartered Colleges and Universities in the Philippines (AACCUP), Inc. (2014). Instruments for accreditation (Rev. ed.) [Unpublished accreditation manual]. AACCUP, Inc.
- [2] Anderson, J., & Rainie, L. (2018, April 17). The future of well-being in a tech-saturated world. Pew Research Center. <https://www.pewresearch.org/internet/2018/04/17/the-future-of-well-being-in-a-tech-saturated-world/>
- [3] Badeo, J. M. O., Duque, D. A. G., & Arnaldo, R. L. (2024). Teachers' implementation of the socio-scientific issues-based approach in teaching science: A needs assessment. *Journal of Technology and Science Education*, 14(2), 363–375. <https://doi.org/10.3926/jotse.1988>
- [4] Behrendt, M., & Franklin, T. (2014). A review of research on school field trips and their value in education. *International Journal of Environmental and Science Education*, 9(3), 235–245. <https://doi.org/10.12973/ijese.2014.213a>
- [5] Capunitan, K. B., Lirado, J. D., & Gregana, C. F. (2023). Motivational factors in science learning, learners' satisfaction, and learning outcomes of pre-service

- teachers. *International Journal of Scientific and Management Research*, 6(5), 72–115. <https://doi.org/10.37502/IJSMR.2023.6504>
- [6] Casey, B. J., Tottenham, N., Liston, C., & Durston, S. (2005). Imaging the developing brain: What have we learned about cognitive development? *Trends in Cognitive Sciences*, 9(3), 104–110. <https://doi.org/10.1016/j.tics.2005.01.011>
- [7] Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge.
- [8] Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approach* (5th ed.). SAGE Publications.
- [9] Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, 24(2), 97–140. <https://doi.org/10.1080/10888691.2018.1537791>
- [10] Department of Education (DepEd). (2016). *K to 12 Science Curriculum Guide (Grades 3–10)*—Department of Education, Republic of the Philippines.
- [11] Department of Education (Philippines). (2001, December 20). DepEd Order No. 56, s. 2001: Policy on educational field trips. Supreme Court E-Library. <https://elibrary.judiciary.gov.ph/thebookshelf/showdocs/10/39615>
- [12] Education: A cultural and historical perspective. (2023). *International Journal of Culture, History and Religion*, 5(2), 45–54. <https://doi.org/10.53894/ijchr.v5i2.2023.45>
- [13] Gadaza, A., Manera, A., Santos, S., Alih, C., & Caban, R. (2025). Reviving the past, teaching the future: The role of Philippine cultural heritage in curriculum development of teacher education programs focus. *International Journal on Culture, History, and Religion*, 7(SI2). <https://doi.org/10.63931/ijchr.v7iSI2.169>
- [14] Guo, S., Shi, L., & Zhai, X. (2024). Validating an instrument for teachers' acceptance of artificial intelligence in education. arXiv preprint. <https://arxiv.org/abs/2401.12345>
- [15] Hallinan, M. T. (2004). The development and validation of a framework for teaching competencies in higher education. *Higher Education*, 48(2), 253–268. <https://doi.org/10.1023/B:HIGH.0000034318.74275.e4>
- [16] Hernández-Ramos, P., et al. (2021). *Teaching socio-scientific issues: A systematic review*. Science & Education. Springer.
- [17] Israel, G. D. (1992). *Determining sample size*. University of Florida Cooperative Extension Service, Institute of Food and Agriculture Sciences, EDIS.

- [18] Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology*, 7(4), 396–403. <https://doi.org/10.9734/BJAST/2015/14975>
- [19] Kelchtermans, G. (2022). Professional development and educational change: Teachers as agents, actors, and subjects. *Journal of Educational Change*, 23(4), 513–529. <https://doi.org/10.1007/s10833-022-09463-5>
- [20] Khatoon, Z., Alam, M. T., Bukhari, M. A., & Mushtaq, M. (2014). In-service teachers' perception about their competencies in the delivery of biology lessons. *International Journal of Asian Social Science*, 4(7), 820–834.
- [21] Lorenzo, E. C. (2016). ICT integration in the educational system of the Philippines. *International Journal of Research Studies in Education*, 5(1), 57–66. <https://doi.org/10.5861/ijrse.2015.1182>
- [22] Manalo, J. A. (2023). Integration of socio-scientific issues in the Philippine Grade 8 science curriculum: Opportunities and challenges. *International Journal of Multidisciplinary: Applied Business and Education Research*, 4(7), 2565–2576. <https://mail.ijmaberjournal.org/index.php/ijmaber/article/view/1824>
- [23] Mohamed, N., & Othman, N. (2021). Experiential learning: Botanical Garden as a place for learning plant science. *Asian Journal of Quality of Life*, 6(2), 142–151.
- [24] OECD. (2019). Teaching and learning international survey (TALIS) 2018 results (Vol. I): Teachers and school leaders as lifelong learners. OECD Publishing. <https://doi.org/10.1787/1d0bc92a-en>
- [25] OECD. (2023). PISA 2022 results: Philippines—Country note. Organisation for Economic Co-operation and Development.
- [26] Pantić, N. (2015). A model for the study of teacher agency for social justice. *Teachers and Teaching*, 21(6), 759–778. <https://doi.org/10.1080/13540602.2015.1044332>
- [27] Park, H., & Sung, J. (2013). The educational change in science teachers: Professional development and reflective practice. *Asia-Pacific Education Review*, 14(4), 511–523. <https://doi.org/10.1007/s12564-013-9272-2>
- [28] Priestley, M., Biesta, G., & Robinson, S. (2015). Teacher agency: An ecological approach. Bloomsbury Academic. <https://doi.org/10.5040/9781472593520>
- [29] Sá, M. J., & Serpa, S. (2023). Education for the digital age: Challenges and opportunities of Education 4.0. *Education Sciences*, 13(2), 183. <https://doi.org/10.3390/educsci13020183>
- [30] Sadler, T. D. (2009). Situated learning in science education: Socio-scientific issues as contexts for learning. *Science & Education*. Springer.

- [31] Sangcap, P., & Tindowen, D. (2024). The influence of teaching competencies on teachers' performance and students' academic achievement in primary science education. *Problems of Education in the 21st Century*, 82(1), 70–85. <https://scientiasocialis.lt/pec/node/1705>
- [32] SEAMEO INNOTECH. (2023). Notes on the Philippines' PISA 2022 results. SEAMEO INNOTECH.
- [33] Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1–22. <https://doi.org/10.17763/haer.57.1.j463w79r56455411>
- [34] Tenopir, C., Dalton, E., Christian, L., Jones, M., McCabe, M., Smith, M., & Fish, A. (2015). Changes in journal use and reading patterns of academics: Results of a U.S. survey. *Journal of the Association for Information Science and Technology*, 66(5), 997–1008. <https://doi.org/10.1002/asi.23304>
- [35] UNESCO. (2023). Technology in education: A tool on whose terms? UNESCO Digital Learning Report 2023. UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000385899>
- [36] Watson, S. (2025, May 8). Higher-order thinking skills (HOTS) in education: Teaching students to think critically. ThoughtCo. <https://www.thoughtco.com/higher-order-thinking-skills-hots-education-3111297>
- [37] Zeidler, D. L., & Nichols, B. H. (2009). Socio-scientific issues: Theory and practice. *Journal of Elementary Science Education*, 21(2), 49–58.