

Science Communication Strategies for Primary Educators for Effective Teaching

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Abstract: *Science communication acts as a catalyst in promoting student-centred learning. In the context of schools, any teacher who engagingly presents scientific concepts becomes a science communicator. Effectively communicating science in the classroom often requires detailed explanations, which may need to be repeated multiple times due to the complexity of the content. A teacher's ability to effectively communicate a scientific concept is a key indicator of their teaching skill. To address this, SEAMEO RECSAM developed 'SciConnect: Bridging Science and Primary Education through Effective Science Communication', a module designed to enhance science teaching in Southeast Asian primary schools. This module was designed based on ADDIE model. A comprehensive study conducted in May 2023 through the "Communication Strategies for Teaching Science to Primary Learners" webinar, which gathered insights from 714 dedicated educators across SEA countries was conducted. A needs analysis conducted during the webinar identified key challenges such as 80% of educators reported challenges in profiling students to tailor teaching contents and expressed difficulties applying storytelling techniques to enhance science lessons. Additionally, over 85% of educators found it challenging to select and adapt science content from credible sources for primary learners and to design interactive class activities for science communication. These findings emphasised the need for a structured module that equips educators with practical tools and strategies. The module integrates core components, including student profiling, media literacy, multimodal communication, storytelling in science, and science writing. Refined with input from five expert reviewers, the final version of the module was pilot-tested in a workshop with in-service primary teachers and district education officers, receiving highly positive feedback. Participant evaluation, collected via a five-point Likert-scale survey, indicated strong agreement (mean scores: 4.2–4.7) on the module's clarity, structure, and practical applicability. Educators particularly valued student profiling, media literacy for science content development, and storytelling techniques to enhance engagement.*

Keywords: Science Communication, Primary Science Education, Teaching Strategies, Teacher Training

1. Introduction

Many countries are working hard to meet the demand for new science and technology development that is sustainable, affordable, and safe, in accordance with the vision of the United Nations' Sustainable Development Goals (SDGs), which are expected to be met by 2030. This can only be accomplished by robust STEM engagement and advancement by the

younger generations. It is expected that 3.5 million STEM positions will remain unfilled by 2025 (Ryan, 2022).

The declining trend in STEM enrolment in Malaysia is evident, with the percentage of students in STEM dropping from 47.18% in 2020 (Bernama, 2021) to 40.95% in 2021 (Idris et al., 2024). By 2023, only 16.64% of Form 4 students opted for the STEM A package (includes core science subjects such as Physics, Chemistry, Biology, and Additional Mathematics) while 5.43% enrolled in the STEM B package (includes applied sciences and technology-related subjects) indicating a continued shift away from science and technology fields (Malay Mail, 2024). This decline poses challenges for Malaysia's future workforce, necessitating urgent interventions from educators, policymakers, and industry stakeholders to enhance STEM interest and participation.

Recent assessments from the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) further underscore the declining science proficiency among Malaysian students. In the 2022 PISA results, only 52% of Malaysian students achieved Level 2 or higher in science, compared to the Organisation for Economic Co-operation and Development (OECD) average of 76% (OECD, 2023). Furthermore, Malaysia is among the top five countries with the most significant declines in test scores across all three core subjects: reading, mathematics, and science, equating to nearly 1.1 years of lost learning in science (OECD, 2023; Azahar & Cheng, 2024).

This downward trend is concerning, as declining interest and proficiency in science can significantly impact the future STEM workforce. A lack of engagement in science education may lead to a shortage of skilled professionals in technology, engineering, and mathematics (Junior Achievement USA, 2024). Addressing this issue requires early intervention in primary education to spark and sustain students' interest in science, ensuring a robust pipeline of talent for STEM careers.

While efforts to implement STEM programs span from government policies to initiatives within local districts, teachers remain the most crucial element in the process (McMullin & Reeve, 2014). Although the curriculum serves only as a guideline, effective STEM education requires a shift toward student-centered pedagogy.

Teachers are expected to play a crucial role in encouraging students to engage in various activities that would cultivate future generations of scientists and create a society that is scientifically literate (Shivni et al., 2021). However, studies have shown that many educators face challenges in effectively communicating science concepts to young learners due to a lack of formal training in science communication strategies (Stevenson, 2024). Addressing this gap requires empowering teachers with practical science communication tools that enhance student engagement, understanding, and curiosity. Effective communication skills enable educators to attract more learners to science and facilitate engagement with STEM-related challenges (Nhlanhla & Zhou, 2015).

Establishing knowledge in students is just as vital as influencing their opinions and attitudes toward the sciences. Research suggests that students' interest in science strongly correlates with how science is presented by educators (Osborne et al., 2003). Effective teaching techniques are ones that aim to transfer knowledge of a particular subject by igniting the learner's interest and fostering a favourable attitude toward both the subject and the knowledge source. Teaching is a process of communication, whether the subject matter is difficult mathematical equations,

complicated scientific notions, or "straightforward and clear" ideas in the humanities (Mohd Hanafiah, 2018).

Science communication involves conveying scientific ideas and information clearly and effectively to a broad audience. This process uses storytelling, hands-on activities, and visual tools to make science more accessible, engaging, and meaningful. In primary education, these strategies are essential for simplifying complex concepts and sparking curiosity among young learners. Science communication aims to evoke specific individual responses, as outlined by the AEIOU framework: Awareness, Enjoyment, Interest, Opinion-forming, and Understanding (Burns et al., 2003). Educators may cultivate these responses by utilising appropriate tools, media, and interactive discourse, fostering a deeper connection between students and science.

Science communication acts as a catalyst in promoting student-centred learning. In the context of schools, any teacher who engagingly presents scientific concepts becomes a science communicator. While traditional pedagogy strictly follows the curriculum, a teacher who captivates students with a compelling story and immerses students in the world of STEM can transform the learning experience into a more student-focused approach (Nemadziva et al. 2023).

Science communication is essential in primary education as it (i) offers real-world context, (ii) highlights the importance of STEM jobs to stimulate student interest, (iii) allows students to clarify terminology in the classroom, and (iv) promotes diversity in science education.

Despite various studies on science communication strategies, limited research explores their application in Southeast Asian primary education settings. While Othman et al. (2022) investigated Southeast Asian students' attitudes toward science, there remains a gap in understanding how science communication strategies are implemented in primary education within this region. This study addresses this gap by focusing on the challenges and needs faced by primary school science teachers in Southeast Asia (SEA) in effectively communicating science.

Based on the findings from the needs analysis and a review of relevant literature, a specialised module was designed to equip teachers with effective science communication strategies, utilising diverse techniques. Furthermore, the effectiveness of this module was evaluated to determine its impact on enhancing science teaching. This study also examines the range and effectiveness of different science communication strategies, providing valuable insights into their role in improving primary science education.

2. Methodology

This study was carried out based on the ADDIE model, which consists of five phases: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. A comprehensive needs analysis was conducted in May 2023 through the "*Communication Strategies for Teaching Science to Primary Learners*" webinar which gathered insights from 714 dedicated educators across SEA countries.

This study utilised a quantitative research methodology through a survey-based needs analysis to identify the challenges encountered by primary school teachers in effectively communicating science. A structured questionnaire integrating Likert-scale questions was employed to gather educators' viewpoints on obstacles in effectively communicate science, as well as their

opinions of training and assistance. The survey was administered online using Google Forms, making it accessible to a wide range of participants from SEA countries.

The needs analysis results were utilised to create a comprehensive science communication module for primary school. The module framework was initially evaluated in August 2023 during RECSAM's Regular Courses, which included 17 primary school educators from Southeast Asian nations. A pre-test and post-test were administered via a structured questionnaire with Likert-scale questions that measured teachers' perceptions prior to and post to their engagement with the module.

The module was further refined with the assistance of five subject matter experts after the initial testing phase. The final version of the module was then implemented in a two-day workshop titled "*SciConnect Series: Inspiring Young Minds through Science Communication*" conducted on January 15, 2025. Two district education officers and four in-service primary school teachers participated in this training. This phase functioned as an evaluation procedure, collecting participant comments to evaluate the module's effectiveness and identifying areas for enhancement.

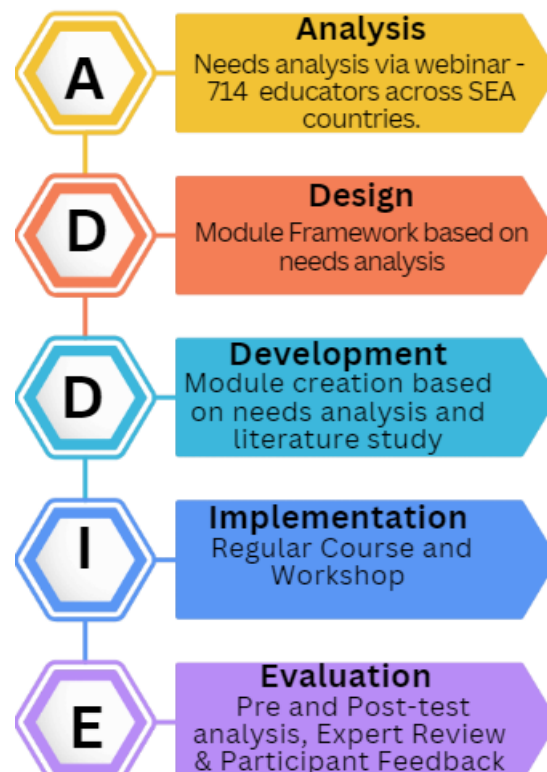


Figure 1: Flowchart of the Research Methodology based on the ADDIE Model.

3. Results and Discussion

3.1 Need Analysis

A total of 714 educators from across Southeast Asia (SEA) participated in a webinar titled *Communication Strategies for Teaching Science to Primary Learners* in May 2023. This webinar, conducted in collaboration with the Malaysian Science Communication Network (MySCN), lasted an hour and focused on the fundamentals of science communication, including student profiling and the integration of technology for effective instruction. To assess

the current challenges educators face in effectively communicating science in classrooms, a need analysis survey was conducted. The survey comprised six key components: demographics, communication skills in teaching, delivery skills, content and classroom activity design, webinar evaluation, and open-ended feedback. Most responses were recorded using a five-point Likert scale ranging from 1 (Limited Knowledge) to 5 (Highly Knowledgeable), ensuring a detailed assessment of educators' competencies and challenges (Wang et al., 2024).

Table 1 presents the distribution of participants by country and gender. A total of 714 participants from 9 SEA countries were recorded. The majority of participants were from Malaysia (639 participants, 89.5%), followed by the Philippines (43 participants, 6.0%), while other countries contributed smaller numbers. Female participants (571, 80.0%) significantly outnumbered male participants (143, 20.0%), indicating a gender disparity among attendees.

Table 1: Participants by Country and Gender

Country	Female	Male	Total
Brunei Darussalam	1	0	1
Cambodia	6	1	7
Indonesia	3	2	5
Lao-PDR	3	4	7
Malaysia	511	128	639
Myanmar	2	1	3
Philippines	41	2	43
Singapore	1	0	1
Thailand	3	5	8
Total			714

Note. The table presents the distribution of participants by country and gender.

Based on the survey data, the majority of participants fall within the 40–49 age group (49.2%), followed by those in the 30–39 age range (24.9%), indicating a strong representation of mid-career educators. The others are 50–59 years (18.2%), Under 30 years (7.6%) and over 60 years (0.1%). In terms of educational qualifications, a significant portion of respondents hold a Bachelor's degree (71.1%), with a notable percentage also possessing Master's qualifications (17.1%), highlighting a well-educated teaching workforce. The rest of the education categories (11.8%) are from diploma, certificate and postgraduate studies. Regarding teaching experience, the largest group has 11–15 years of experience (21.1%), followed closely by those with 6–10 years (19.6%) and 16–20 years (19.2%), suggesting that most respondents are experienced educators. Additionally, 17.4% have been teaching for 21–25 years, while a smaller percentage (11.6%) are relatively new to the field with 1–5 years of experience. These findings indicate that the study primarily engaged highly qualified and experienced educators, providing valuable insights into the challenges and needs of teachers in science communication.

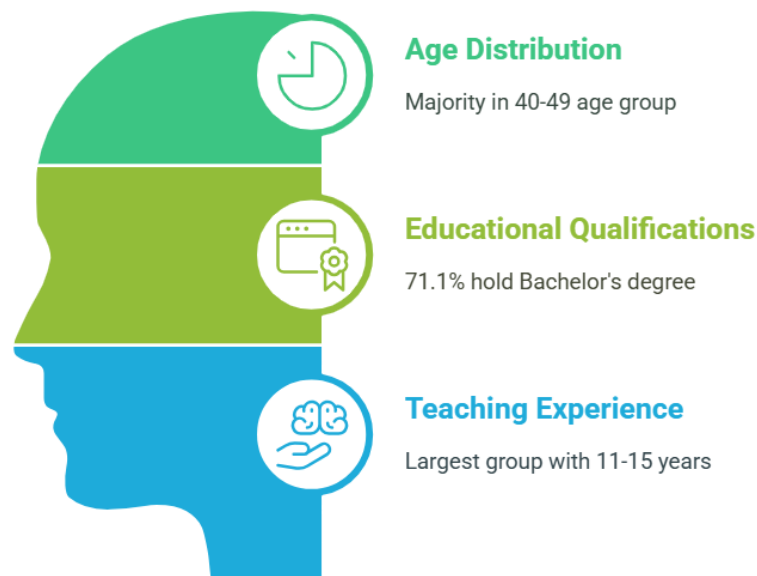


Figure 2: Demographic summary of SEA country educators who participated in the need analysis

3.1.1 Challenges in Science Communication

Survey responses highlight several key challenges faced by educators in effectively communicating science:

Student Profiling and Differentiation

Student profiling emerged as another major concern, with 80% of respondents rating it as a challenge when tailoring teaching content. This issue is consistent with Tomlinson (2017), who highlighted that many educators face difficulties in implementing differentiated instruction due to inadequate training in assessing student needs and learning styles. A lack of student profiling skills may hinder teachers from effectively engaging students with varying levels of prior knowledge and learning preferences.

Challenges in Storytelling as a Pedagogical Tool

Storytelling techniques, an essential tool for making science lessons more engaging, were also identified as a difficulty by 80% of educators. This aligns with Klassen (2010), who emphasised that while storytelling enhances engagement and comprehension, many educators lack the training required to integrate narrative-based instruction effectively. Given the strong evidence that storytelling can improve conceptual understanding, structured professional development in this area is essential.

Science Content Selection

The process of selecting and adapting science content from credible sources proved to be one of the most significant hurdles, as 85% of respondents struggled with this aspect, with 54% considering it a high-level challenge. This finding aligns with McFarlane (2013), who reported that many teachers rely on textbooks and online resources without critically assessing their accuracy, leading to misconceptions in science education. Without formal training in evaluating scientific sources, educators may struggle to present accurate and digestible information to students.

Design of Interactive Classroom Activities

The design of interactive class activities for science communication was another area of difficulty, with 83% of educators rating it as a moderate to high challenge. This suggests that while educators recognise the importance of active learning, many lack the necessary resources or pedagogical strategies to implement it effectively.

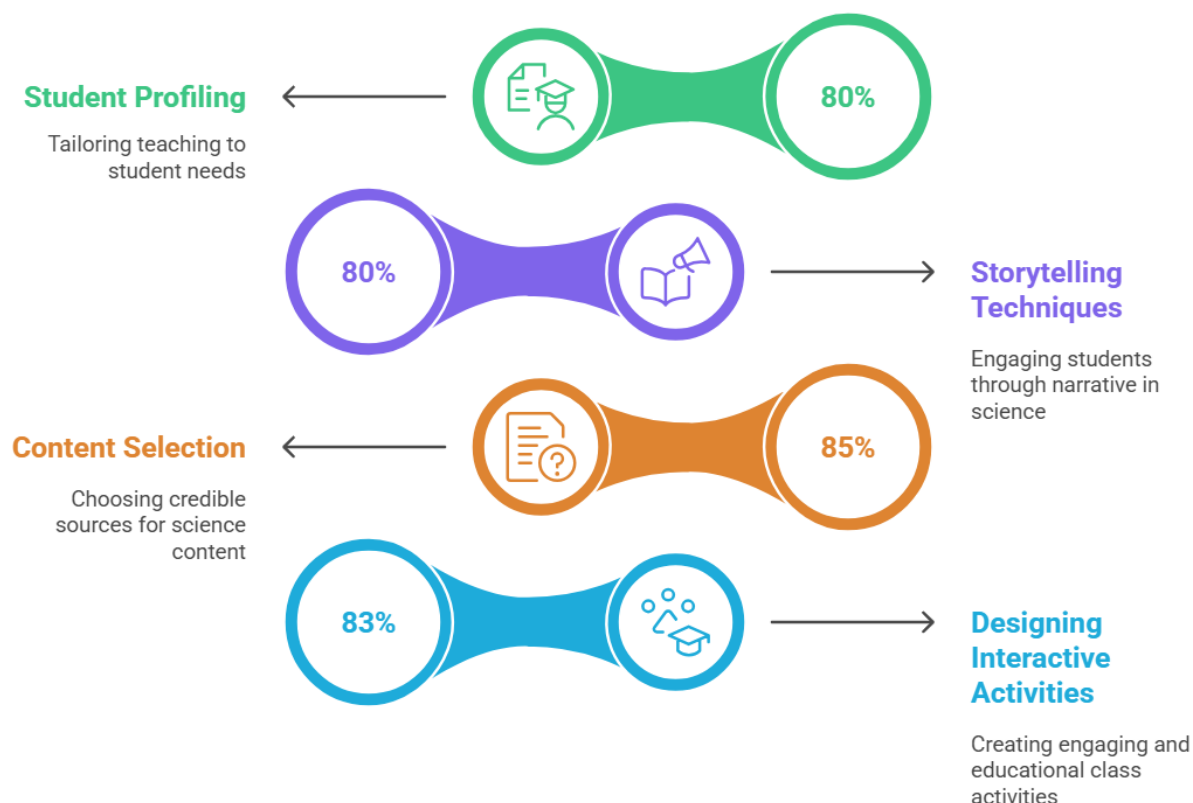


Figure 3: Challenges face by SEA country educators in effectively communicating science

3.1.2 Educators' Perspective on Science Communication

The survey results indicate a strong consensus among educators regarding the importance of communication skills in teaching science. A significant 59.4% of respondents agreed, while an additional 31.8% strongly agreed, making a total of 91.2% who recognise effective communication as a crucial factor in science education. A small proportion remained neutral (8.0%), and only 0.8% disagreed or strongly disagreed. These findings are supported by Norris and Phillips (2003), who argue that science literacy extends beyond knowledge acquisition to include the ability to convey scientific concepts clearly and effectively.

Similarly, there was strong support for the development of a module to enhance teachers' ability to communicate science using appropriate modes and techniques. A combined 91.2% of respondents agreed or strongly agreed on the necessity of such a module (59.4% agreed, while 31.8% strongly agreed). Meanwhile, 8.0% were neutral, and only 0.8% disagreed or strongly disagreed. The findings emphasise the urgent need for a structured science communication module to address these challenges and support educators effectively (Nemadziva et al., 2023). These findings provided valuable insights for the development of a science communication module tailored for primary educators.



Figure 4: SEA country educators' perspective on importance of Science Communication

3.2 Module Development

The SciConnect module was developed in response to findings from the needs Analysis Survey, which highlighted key challenges faced by primary educators in effectively communicating science concepts. The survey revealed that educators required support in student profiling, content development, integrating storytelling and communication techniques to engage learners and communities.

To address these gaps, SEAMEO RECSAM developed 'SciConnect: Bridging Science and Primary Education through Effective Science Communication'. This structured module provides practical tools and strategies to enhance educators' science communication competencies and was piloted through SEAMEO RECSAM's Regular Courses demonstrating measurable improvements in teaching effectiveness.

3.2.1 SciConnect Module: Structure and Alignment with Needs Analysis

The module consists of six chapters, each strategically designed to address specific challenges identified in the needs Analysis.

Table 2: SciConnect Module summary

Chapter	Focus Area	Needs Analysis Findings Addressed	Key Module Topics
Chapter 1: Crafting Connections	Introduction to Science Communication	91.2% of educators recognise the importance of science communication but lack structured training.	Definition, role, and goals of science communication; Importance in primary education.
Chapter 2: Student Profiling	Understanding Student needs	80% of educators struggle with student profiling and tailoring content for diverse learners.	Student profiling methods: cultural background, learning styles, language proficiency, socioeconomic factors, tailored content.
Chapter 3: Developing Content	Content Development & Media Literacy	85% find it challenging to select credible content, and 83% struggle with interactive activities.	Media literacy, eliminating jargon, building arguments, lateral reading, designing interactive content.
Chapter 4: Varied Communication Forms	Exploring Different Communication Methods	80% report difficulties integrating storytelling,	Oral, non-verbal, visual, and collaborative communication; museum

		visual, and oral communication into lessons.	visits, infographics, show-and-tell.
Chapter 5: Science Speak	Enhancing Verbal & Non-Verbal Science Teaching	80% report difficulties integrating storytelling, visual, and oral communication into lessons.	Storytelling, humor, body language, audience participation, scientific argumentation.
Chapter 6: Written Communication	Effective Written & Digital Science Communication	Science writing skills are essential for primary educators (Yore, Hand, & Florence, 2004).	Effective writing techniques, visual aids, engaging parents, digital newsletters, social media in science teaching.

Note: The table represent the content of Sciconnect module in adherence with the need analysis

Chapter 1 introduces the fundamental principles of science communication, providing a structured framework to help educators make science accessible and engaging. This addresses the finding that 91.2% of educators recognised the importance of science communication but lacked structured training.

Chapter 2 focuses on student profiling, helping educators tailor their lessons by considering cultural backgrounds, learning styles, language proficiency, and socioeconomic factors. This responds to the 80% of educators who struggled with student profiling and content adaptation.

To improve content credibility and interactive lesson design, Chapter 3 enhances media literacy skills, helping educators critically evaluate sources, eliminate jargon, and build scientific arguments. This is crucial, as 85% found it difficult to select credible content, and 83% struggled with designing interactive lessons.

Chapters 4 and 5 focus on verbal and visual communication, addressing the challenge that 80% of educators had difficulties integrating storytelling, visual, and oral communication into lessons. Chapter 4 introduces oral, visual, and collaborative communication techniques, while Chapter 5 expands on these skills with storytelling, humor, body language, and audience participation, making science more engaging.

Chapter 6, included based on literature analysis, highlights the importance of science writing skills in developing scientific literacy (Yore, Hand, & Florence, 2004). This chapter teaches concise, clear writing techniques and introduces digital communication strategies such as social media, newsletters, and e-books to engage parents and extend science learning beyond the classroom.

Overall, SciConnect systematically addresses key challenges in science education by integrating verbal, visual, and written communication techniques, ensuring educators are well-equipped to deliver engaging and effective science lessons.

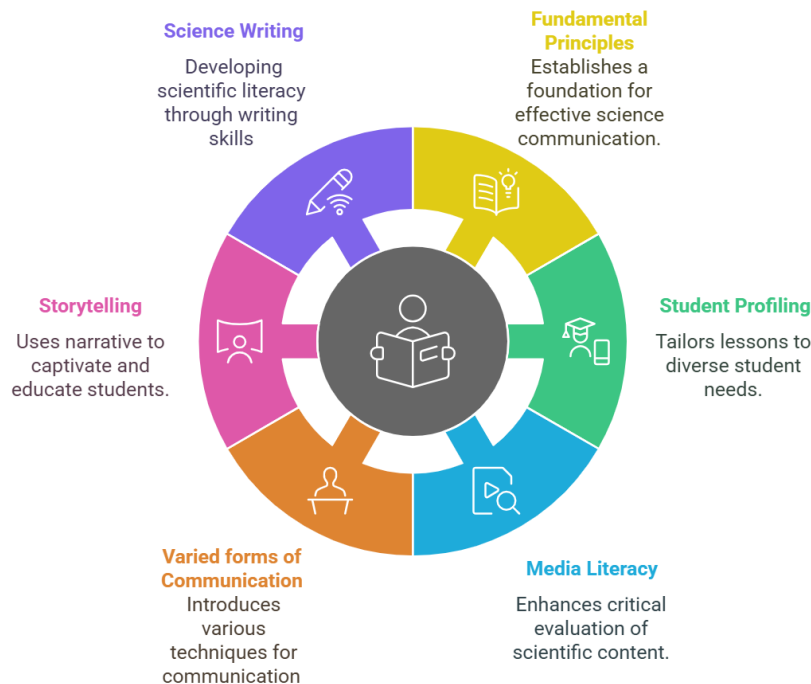


Figure 5: SciConnect Module content

3.3. Module Framework Implementation and Evaluation process

Participant Demographics

A total of 17 participants were involved in this study during RECSAM's four weeks Regular Course in August 2023, representing a diverse group of educators. Among them, 4 were male and 13 were female. The participants came from 8 different countries, with the highest representation from Indonesia, Cambodia, Malaysia, Brunei Darussalam, and Lao-PDR.

Survey Structure

The pre-test and post-test surveys were designed to assess participants' competencies before and after engaging with the module framework. To simplify the analysis, the survey items were grouped into four key educational categories:

- 1) **Communication Skills in Teaching** – This category includes all crucial for effective forms of science communication including student profiling for tailored content.
- 2) **Delivery Skills** – Focused on story-telling techniques and the ability to engage students through structured content delivery.
- 3) **Choosing the Right Content** – Evaluated how well participants were able to select and utilise appropriate teaching materials and sources through media literacy
- 4) **Varied Forms of Communication** – Measured the ability to use different modes of communication to enhance student understanding and engagement.

Pre-test and Post-test Analysis

The comparison of pre-test and post-test scores highlights significant improvements in participants' competencies after engaging with the module framework. The results are summarised in Figure X, showcasing the absolute gain in four major categories:

- Student Profiling – This skill showed the highest improvement, increasing from 2.65 (pre-test) to 4.18 (post-test), with a gain of 1.53.
- Varied Forms of Communication – Improved from 2.29 to 3.76, with a gain of 1.47.
- Choosing the Right Content – Increased from 2.94 to 4.35, achieving a gain of 1.41.
- Story Telling Techniques – Saw a significant rise from 2.47 to 3.71, with a gain of 1.24.

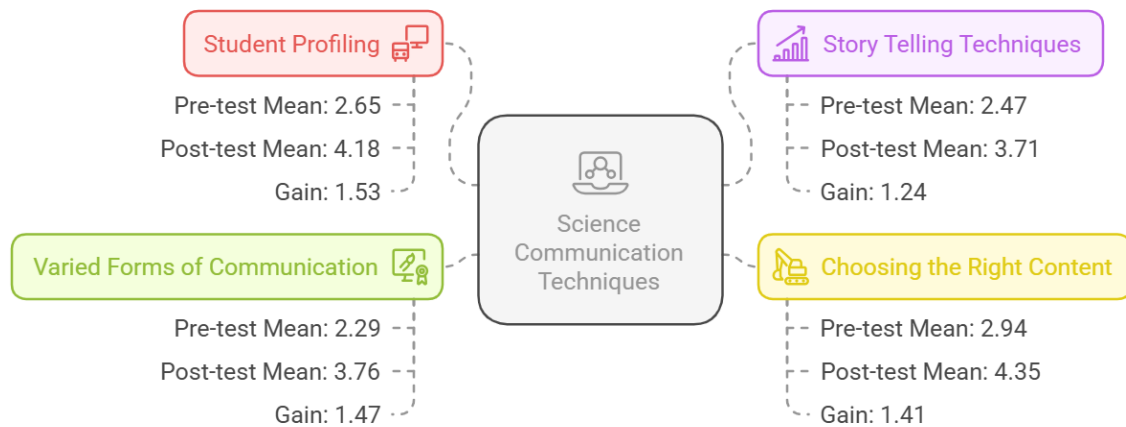


Figure 6: Pre and Post test analysis of module framework

The results indicate that participants demonstrated notable improvements in all key areas, with the most significant progress in Student Profiling and Communication techniques. These findings highlight the effectiveness of the module framework in enhancing educators' teaching and communication skills.

3.4 Feedback for the Final Module

A two-day workshop titled '*SciConnect: Inspiring Young Minds through Science Communication*' was held at SEAMEO RECSAM on January 15–16, 2025, to gather feedback on the final version of the SciConnect module. Six participants—comprising four primary educators and two district officers—attended the workshop. Their feedback was collected through a Likert-scale Google Form survey, using a five-point scale where 1 represented Strongly Agree and 5 represented Strongly Disagree.

Participants evaluated how well the module enhanced their teaching techniques, confidence, and student engagement strategies. Overall, the workshop received highly positive feedback, with mean scores ranging from 4.2 to 4.7. Educators particularly valued hands-on teaching strategies, including student profiling, science content development using media literacy, and storytelling techniques to enhance engagement.

Despite the limited sample size, the feedback strongly supports the effectiveness of the science communication module in improving teaching confidence and student engagement. Future workshops will focus on further refining these approaches, incorporating additional hands-on activities and peer collaboration to maximise their impact on educators and students.



Figure 7: Key areas of impact identified in participant feedback

4. Conclusion

This study highlights the critical role of science communication in enhancing primary science education and addresses key challenges faced by educators in SEA countries. The findings from the needs analysis revealed that educators struggle with student profiling, content selection, storytelling techniques, and the design of interactive classroom activities. In response, the ‘SciConnect: Bridging Science and Primary Education through Effective Science Communication’ module was developed as a structured approach to equip educators with practical strategies to enhance their communication skills in science teaching process.

The module was systematically designed using the ADDIE model. The evaluation stage for the module framework through pre- and post-test analysis, demonstrating significant improvements in participants' competencies. Notably, the greatest enhancements were observed in student profiling and varied forms of communication, confirming the module's effectiveness in addressing the identified challenges. Educators feedback further reinforced its applicability for the final version of the module, with high levels of satisfaction reported in areas such as media literacy, storytelling, and student engagement techniques.

As science education continues to evolve, the integration of science communication strategies remains essential for fostering students' interest and understanding from the primary level. Future research should explore scaling the SciConnect module across diverse educational settings, incorporating more hands-on workshops, and assessing its long-term impact on teaching practices and student learning outcomes. Strengthening partnerships between educators, policymakers, and researchers will be crucial in ensuring sustainable improvements in science teaching across Southeast Asia.

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