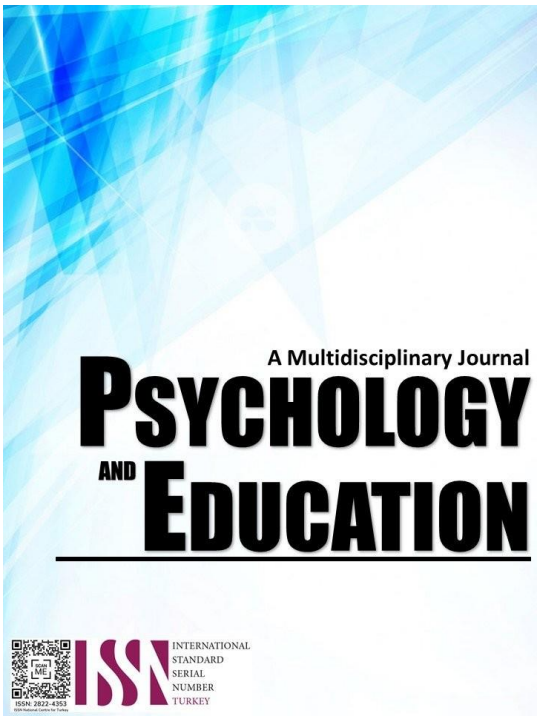
LEARNING ACTION CELL PRACTICES AND PERFORMANCE OF SCIENCE TEACHERS IN ENHANCING 21ST – CENTURY SKILLS: INDIGENOUS-BASED OUTPUT FOR A LAC TEMPLATE MODEL



PSYCHOLOGY AND EDUCATION: A MULTIDISCIPLINARY JOURNAL

Volume: 34
Issue 2
Pages: 232-247
Document ID: 2025PEMJ3253
DOI: 10.70838/pemj.340207
Manuscript Accepted: 03-05-2025

Psych Educ, 2025, **34**(2): 232-247, Document ID:2025PEMJ3253, doi:10.70838/pemj.340207, ISSN 2822-4353

Research Article

Learning Action Cell Practices and Performance of Science Teachers in Enhancing 21st – Century Skills: Indigenous-Based Output for a LAC Template Model

Jeanly S. Jaleco,* Christine P. Abo
For affiliations and correspondence, see the last page.

Abstract

This study explores the impact of Learning Action Cell (LAC) practices on science teachers' classroom performance, focusing on the integration of 21st-century skills—critical thinking, creativity, communication, and collaboration—into teaching. The LAC model, a collaborative professional development strategy, enhances instructional practices to foster these competencies. Focusing on four key practices—problem identification, collaborative learning, action planning, and reflection—the study uses a mixed-methods approach to assess teaching effectiveness through the Classroom Observation Tool (COT) and teachers' perceptions of 21st-century skills. Findings show that LAC practices significantly improve teaching strategies, particularly in addressing learner diversity, curriculum planning, and assessment. The integration of 21st-century skills resulted in increased student engagement and better learning outcomes. Based on these results, the study proposes an Indigenous LAC Template Model, which adapts LAC practices to the unique needs of teachers in indigenous communities. This model incorporates culturally responsive teaching methods and evidence-based strategies to support ongoing professional development, empowering educators to equip students with the skills needed for success in the modern world.

Keywords: *Learning Action Cell (LAC), 21st - century skills, science education, culturally responsive teaching*

Introduction

The 21st century demands that students develop critical thinking, creativity, collaboration, and communication skills. Science education promotes these competencies through inquiry-based learning and problem-solving (Trilling & Fadel, 2009). However, to integrate these skills effectively, teachers need continuous professional development. The Learning Action Cell (LAC) model, a collaborative professional development strategy, has proven effective in improving teachers' instructional practices and aligning them with essential competencies.

Despite the importance of 21st-century skills, many science teachers in indigenous communities' face challenges in integrating them into their teaching. Traditional professional development models often overlook the cultural contexts of indigenous communities, creating a gap between modern education and indigenous knowledge (Villegas & Lucas, 2002). Culturally responsive teaching, which Gay (2010) argues enhances student engagement, is often lacking in professional development programs. This disconnection limits effective pedagogy and student learning. Therefore, a culturally relevant, localized framework is essential for empowering teachers in these communities.

The LAC model offers a solution by fostering collaboration and reflective learning. Teachers share best practices, engage in peer learning, and address instructional challenges (Darling-Hammond et al., 2017). Studies show that collaborative professional development improves teaching more than traditional methods (Vescio, Ross, & Adams, 2008). Desimone (2009) emphasizes that LAC promotes continuous learning and enhances teaching strategies. In science education, inquiry-based learning combined with professional development has been shown to improve student engagement and achievement (National Research Council, 2000).

This study explores the current practices and performance of science teachers in indigenous communities participating in LAC sessions, focusing on the integration of 21st-century skills into their teaching. The research aims to develop the Indigenous LAC Template Model, a culturally responsive framework tailored to the unique needs of science teachers in indigenous contexts. This model bridges the gap between indigenous knowledge and modern educational frameworks, offering a solution for improving science education in these communities.

The study was conducted during the first quarter of the 2024-2025 academic year. The first phase involved reviewing existing LAC practices at T'boli National High School. The subsequent phase focused on developing and implementing the Indigenous LAC Template Model, followed by an evaluation of its effectiveness in enhancing the integration of 21st-century skills in science education.

The effectiveness of Learning Action Cell (LAC) practices in professional development has been well-documented, particularly in promoting teacher collaboration, reflective practice, and continuous improvement in instructional strategies (Brown, 2019; Smith & Jones, 2021). LACs foster a collaborative learning environment where teachers can share successful teaching practices, address instructional challenges, and engage in problem-solving, which ultimately enhances their ability to integrate 21st-century skills into their classrooms (Chang & Lee, 2020; Patel et al., 2019). These practices are crucial for developing critical thinking, creativity, communication, and collaboration among students, which are essential competencies in today's educational landscape (Trilling & Fadel, 2019; Mamaril & Salvacion, 2020).

In the context of indigenous education, it is essential to integrate culturally responsive teaching to ensure that education remains relevant

and respectful of students' cultural backgrounds (Gay, 2010; Sleeter, 2011). Traditional professional development models often overlook the cultural needs of indigenous communities, creating a gap between modern teaching methods and indigenous knowledge systems (Villegas & Lucas, 2002). The importance of culturally inclusive teaching has been emphasized in policies such as Republic Act No. 8371, which calls for the integration of indigenous knowledge into the curriculum (Republic of the Philippines, 1997). The Department of Education's guidelines for implementing LACs further reinforce the value of culturally responsive professional development that addresses the unique needs of indigenous students and teachers (DepEd, 2011; DepEd, 2016).

The findings of previous studies show that LACs significantly contribute to improving teaching effectiveness by fostering collaboration and reflective practice (Vescio, Ross, & Adams, 2008; Desimone, 2009). Teachers who engage in LACs report positive changes in their instructional practices, including the integration of innovative teaching methods and the adaptation of curriculum designs (Patel et al., 2019). In addition, LACs have been shown to be effective in supporting the development of 21st-century skills, ensuring that educators are equipped to facilitate student engagement and academic achievement (Darling-Hammond et al., 2017; Trilling & Fadel, 2019).

This study draws from these findings to develop an Indigenous LAC Template Model that aligns LAC practices with culturally responsive teaching methods tailored to the needs of science teachers in indigenous communities. This model aims to bridge the gap between modern education and indigenous knowledge, ensuring that science education in these communities integrates 21st-century skills while remaining culturally relevant and respectful.

Research Questions

The purpose of this study is to examine how Learning Action Cell (LAC) practices contribute to improving the teaching performance of science educators, particularly in the integration of critical thinking, creativity, collaboration, and communication—key 21st-century skills. The research aims to fill the gap in professional development approaches that are specifically designed for indigenous contexts, offering a model that can be customized to enhance teaching quality and student achievement. This study will explore the following research questions:

1. What is the level of practices of science teachers in LAC sessions in terms of:
    1.1. problem identification;
    1.2. collaborative learning;
    1.3. action planning; and
    1.4. reflection and feedbacking?
2. What is the level of classroom performance of science teachers based on Classroom Observation Tool (COT) in terms of:
    2.1. content knowledge and pedagogy;
    2.2. diversity of learners;
    2.3. curriculum and planning; and
    2.4. assessment and reporting?
3. What is the extent of mastery on 21st century skills of science teachers measured in terms of:
    3.1. critical thinking;
    3.2. creativity;
    3.3. communication; and
    3.4. collaboration?
4. Is there a significant relationship between the level of practices in LAC sessions and the level of classroom performance of science teachers?
5. Is there a significant difference between the 21st century skills of science teachers before and after the LAC session implementation?
6. Is there a significant relationship between the level of practices in LAC sessions and the level 21st century skills of science teachers?
7. How are the perceived challenges and benefits associated with the implementation of LAC sessions affect teachers across science specializations?
8. How do LAC sessions affect science teachers' 21st Century Skills in terms of:
    8.1. critical thinking;
    8.2. creativity;
    8.3. communication; and
    8.4. collaboration?

Methodology

Research Design

This study adopts an Explanatory Sequential Mixed-Methods Design, which integrates both quantitative and qualitative research approaches to provide a well-rounded understanding of the impact of Learning Action Cell (LAC) practices on science teachers'

classroom performance, particularly their integration of 21st-century skills. As Creswell and Plano Clark (2011) emphasize, this design allows for a comprehensive approach, providing both statistical analyses to examine the general trends and qualitative insights to explore the contextual experiences and challenges that might not be captured through quantitative measures alone. Johnson and Onwuegbuzie (2004) assert that mixed-methods research provides a more complete perspective by addressing complex research questions that neither method can fully address on its own.

The quantitative phase of the study employs a Quasi-Experimental Design, which is often used in educational settings when random assignment is not feasible, but there is still a need to assess the effects of an intervention, such as the LAC practices in this case. Gall, and Borg (2007) highlight the usefulness of quasi-experimental designs in educational research, as they allow for evaluating changes in teaching practices and learning outcomes while controlling for extraneous variables. Surveys will be administered to gather demographic data, as well as information on teachers' perceptions regarding the integration of 21st-century skills and their experiences with LAC. The Classroom Observation Tool (COT), based on DepEd Order No. 42, s. 2017, will be used to observe teachers' practices in the classroom, specifically focusing on how well these skills are being integrated into instruction. Classroom observation, as discussed by Merriam (2009), is crucial for providing objective insights into actual teaching practices, as opposed to self-reported data.

The qualitative phase utilizes a Phenomenology design, which is particularly suited to exploring the lived experiences of teachers involved in LAC. Moustakas (1994) asserts that phenomenology is appropriate for understanding how individuals perceive and make sense of their experiences. This phase involves semi-structured interviews, which are designed to encourage teachers to share their insights and challenges in implementing LAC practices. These in-depth interviews provide a rich, narrative understanding of the emotional, cognitive, and practical dimensions of LAC participation and its effect on integrating 21st-century skills. The qualitative data will complement the quantitative findings by providing deeper insights into the teachers' personal and professional growth through LAC participation.

Participants

The study involves 17 science teachers from T'boli National High School, selected through purposive sampling. Purposive sampling is particularly suited for this study as it allows the researcher to select participants who possess specific characteristics relevant to the research question, ensuring that they are capable of providing meaningful insights into the impact of LAC practices. Palinkas et al. (2015) highlight that purposive sampling is often used in educational research when the researcher seeks participants who have direct experience or expertise in a specific area, such as LAC participation in this case. The sample consists of teachers who are actively involved in LAC sessions and teach science, ensuring that their experiences are directly relevant to the study's aims. While purposive sampling provides valuable, context-rich data, Etikan, Musa, and Alkassim (2016) caution that it may introduce selection bias, as it may exclude the experiences of teachers who have not participated in LAC sessions, potentially limiting the generalizability of the findings.

Instrument

This study employed a mixed-methods approach utilizing pre-test and post-test assessments, a survey questionnaire, classroom observations, and semi-structured interviews to evaluate the Learning Action Cell (LAC) practices and their impact on science teachers' mastery of 21st-century skills. A multiple-choice pre-test and post-test assessed teachers' level of LAC practices, while a survey questionnaire measured their proficiency in critical thinking, creativity, collaboration, and communication (Creswell & Creswell, 2018). The Classroom Observation Tool (COT) (DepEd Order No. 42, s. 2017) was used to evaluate teaching practices in key domains, and semi-structured interviews provided qualitative insights into teachers' experiences with LAC sessions (Patton, 2015).

To ensure validity, the instruments underwent expert review by three science educators, all graduates of MST-General Science or MST-Physics. Revisions were made based on their feedback to enhance content clarity and alignment with study objectives. Pilot testing with 75 science teachers from schools outside T'boli National High School was conducted, followed by item analysis to refine test items. Questions categorized as "very easy" or "very difficult" were removed, reducing the test from 40 to 32 items (Cohen, Swerdlik, & Sturman, 2013). Reliability was assessed using Cronbach's alpha, yielding a score of 0.846, indicating excellent internal consistency (DeVellis, 2017). The survey responses were rated on a 4-Point Likert Scale, while classroom performance was evaluated using a 7-Point Likert Scale to ensure precise measurement.

Purposive sampling was employed, ensuring the inclusion of science teachers actively engaged in LAC sessions. While this method ensured relevance, potential biases related to sample representativeness were acknowledged. To mitigate these, data were triangulated across multiple instruments, enhancing the study's rigor (Cohen, Manion, & Morrison, 2018). Through these systematically designed instruments, this study provides empirical evidence on the effectiveness of LAC practices in enhancing science teachers' classroom performance and mastery of 21st-century skills, serving as a foundation for an indigenized LAC template model.

Procedure

The primary research instruments are the pre-test and post-test, designed to assess changes in science teachers' classroom practices and their integration of 21st-century skills. These instruments were subjected to a rigorous validation process to ensure they accurately measure the intended constructs. DeVellis (2016) recommends expert review for content and face validity, ensuring that the items in

the instruments are both relevant and clear. In this study, the pre-test and post-test instruments were reviewed by experienced science educators and administrators to ensure that they were appropriate for the study context.

Pilot testing was also conducted with 75 science teachers from other schools, allowing for feedback on the clarity and relevance of the items. Cohen, Manion, and Morrison (2018) emphasize that pilot testing is an essential step in refining research instruments, as it helps identify and correct any issues before full-scale data collection. After pilot testing, items that did not meet acceptable discrimination indexes were revised or excluded, as per the guidelines provided by Cohen et al. (2018). The final instrument consists of a Likert scale for measuring teachers' perceptions of their mastery of 21st-century skills and a Classroom Observation Tool (COT), which is adapted from the Philippine Professional Standards for Teachers. The COT ensures that observations align with the national framework for teacher development, allowing for a consistent and standardized approach to assessing teaching practices.

Data Analysis

To measure the effect of LAC session practices on the development of 21st-century skills (critical thinking, creativity, collaboration, and communication) among science teachers, a combination of quantitative and qualitative data analysis methods will be used. The quantitative analysis will begin with the calculation of mean and standard deviation to assess the overall level of LAC practices and classroom performance before and after the implementation of LAC sessions. These descriptive statistics help summarize the central tendency and variability in the data, providing insights into the overall distribution and trends (Field, 2018). Additionally, the mean and standard deviation will be computed for pre- and post-test scores to examine changes in the 21st-century skills of the science teachers. This will allow for the comparison of skill levels before and after the LAC intervention, with effect size measures, specifically Cohen's d, being used to determine the magnitude of any changes in scores (Cohen, 1988). The effect size provides a clearer understanding of the practical significance of the intervention, helping to assess whether the changes are not only statistically significant but also meaningful in real-world terms.

To explore the relationship between LAC practices and classroom performance, Spearman's rho correlation will be employed to assess the strength and direction of the relationship between these two variables. Since Spearman's rho is a non-parametric test, it is particularly suited for evaluating monotonic relationships between ordinal variables (Field, 2018). Additionally, the Wilcoxon signed-rank test, a non-parametric method, will be used to compare teachers' 21st-century skills before and after the LAC sessions. This test is ideal for paired samples and will help detect significant differences in skill development, especially considering the non-normal distribution of data and the small sample size (Mann & Whitney, 1947; Field, 2013).

In terms of qualitative data analysis, Thematic Analysis will be used to explore teachers' perceptions of the LAC sessions and their impact on 21st-century skills. Interview recordings and open-ended survey responses will be transcribed and coded to identify recurring themes and patterns related to LAC practices and the development of these skills. Codes will be categorized into broader themes that reflect the essence of participants' experiences (Braun & Clarke, 2006). To strengthen the validity of the findings, triangulation will be applied by comparing qualitative data (interviews and open-ended survey responses) with quantitative data (pre- and post-test scores) to enrich the interpretation of results (Patton, 1999). Finally, Classroom Observation Tool (COT) data will be analyzed using descriptive statistics such as frequency and percentage to identify the prevalence of specific teaching practices aligned with 21st-century skills. The observation notes will also be examined to identify key behaviors and practices that either align with or diverge from the targeted skills.

By integrating both quantitative and qualitative findings, this research will provide a comprehensive understanding of the impact of LAC sessions on the 21st-century skills of science teachers. Patterns and discrepancies between the two types of data will be explored, with conclusions drawn on the effectiveness of LAC practices and recommendations made for future improvements, particularly in the context of culturally sensitive education (Teddlie & Tashakkori, 2009).

Results and Discussion

This section includes the presentation, analysis and interpretation of quantitative and qualitative data that were collected in the first phase and second phase, respectively.

Quantitative Phase

Level of LAC Sessions Practices of Science Teachers

Table 1 evaluates the level of Learning Action Cell (LAC) practices of science teachers based on four indicators: Problem Identification, Collaborative Learning, Action Planning, and Reflection and Feedbacking. Each indicator has a highest possible score of 8 points.

The results from Table 1 highlight key areas of professional development during LAC sessions among science teachers. Reflection and Feedbacking emerged as the strongest practice (M = 7.47, SD = 0.72), suggesting that teachers actively engage in self-assessment and peer evaluation, which fosters continuous improvement (Chang & Lee, 2020; Avalos, 2011). Reflection allows teachers to assess their methods and refine their strategies, directly contributing to integrating 21st-century skills into their teaching (Desimone, 2009). This process empowers teachers to better meet students' needs through ongoing self-improvement.

Table 1. *Mean Distribution and Qualitative Description on the Level of LAC Sessions Practices of Science Teachers*

Indicator	*N*	*Mean*	*SD*	*Description*
Problem Identification	17	6.65	.79	High Level
Collaborative Learning	17	7.41	.62	Very High Level
Action Planning	17	7.35	.79	Very High Level
Reflection and feedbacking	17	7.47	.72	Very High Level
Overall	17	7.22	.73	Very High Level

However, Problem Identification (M = 6.65, SD = 0.79) showed the lowest score, indicating a gap in systematically defining and addressing instructional challenges. While teachers can recognize problems, turning these into actionable solutions remains a challenge. Patel et al. (2019) stress the importance of problem identification in diagnosing instructional gaps, but without structured support, teachers may struggle to implement effective changes (Smith & Jones, 2021). To address this, more focused training on problem-solving strategies could help teachers translate recognized challenges into effective classroom practices. Collaborative Learning (M = 7.41, SD = 0.62) was another strength, highlighting the value of teamwork and shared learning.

Collaborative professional development encourages teachers to exchange ideas, share best practices, and co-develop strategies, fostering a supportive learning environment (Brown, 2019; Darling-Hammond et al., 2017). The low standard deviations across all areas suggest that LAC sessions consistently promote these practices, ensuring a stable learning environment (Trilling & Fadel, 2019).

To further improve the effectiveness of LAC sessions, more structured support in Problem Identification would help teachers better diagnose and address instructional challenges. Workshops or case studies focused on systematic problem-solving could provide the guidance necessary for turning identified issues into actionable improvements. Strengthening problem identification will not only enhance reflective and collaborative practices but also lead to more meaningful instructional changes, directly benefiting student outcomes.

In summary, while LAC sessions effectively promote reflection and collaboration, improving the problem identification process could create a more balanced and impactful professional development experience. By offering structured training on diagnosing and addressing instructional challenges, LAC sessions could better support teachers in enhancing their practices and ultimately improve teaching effectiveness (Chang & Lee, 2020; Patel et al., 2019).

Level of Classroom Performance of Science Teachers Based on Classroom Observation Tool (COT)

Table 2 compares the pre and post lesson observation performance of science teachers using the classroom observation tool. The performance levels are assessed across four indicators on a 7-point Likert scale. The indicators include Content Knowledge and Pedagogy, Diversity of Learners, Curriculum and Planning, and Assessment and Reporting. The data in Post LAC session includes the total mean and standard deviation from three series of classroom observations.

Table 2. *Mean Distribution and Qualitative Description of the Level of Classroom Performance of Science Teachers Based on Classroom Observation Tool*

		Pre LACs		*Post LACs*		
Indicator	*N*	*Mean*	*SD*	*Mean*	*SD*	*Description*
Content Knowledge and Pedagogy	17	5.03	.65	6.63	0.44	Improved from Good to Very Good
Diversity of Learners	17	4.71	.52	6.17	0.48	Improved from Satisfactory to Very Good
Curriculum and Planning	17	4.31	.38	5.84	0.45	Improved from Satisfactory to Good
Assessment and Reporting	17	4.59	.51	5.97	0.54	Improved from Satisfactory to Good
Overall	17	4.66	.55	6.11	0.48	Improved from Satisfactory to Very Good

Table 2 presents the results on the science teachers' perceptions of the effectiveness of LAC sessions in enhancing their 21st-century skills. The data reveals that Communication (M = 7.35, SD = 0.67) is viewed as the most developed skill during LAC sessions, suggesting that teachers feel they have improved their ability to communicate effectively in both teaching and collaboration. Effective communication is critical in fostering student engagement and collaboration, as it helps teachers articulate ideas and share information with clarity (Darling-Hammond et al., 2017). Teachers' improved communication skills also contribute to creating a more collaborative and student-centered classroom environment (Trilling & Fadel, 2019).

Critical Thinking (M = 6.92, SD = 0.71) showed the second highest score, indicating that LAC sessions have helped teachers strengthen their ability to analyze and evaluate information critically. This is important for developing students' higher-order thinking skills, as teachers who engage in critical thinking are more likely to foster these skills in their students (Desimone, 2009). Teachers' self-reports of enhanced critical thinking suggest that they are better equipped to design lessons that challenge students to think critically and creatively.

In contrast, Creativity (M = 6.45, SD = 0.85) had the lowest mean score, pointing to a potential area for improvement. While teachers recognize the value of creativity in teaching, there is still room for growth in integrating creative strategies into their instruction. Creativity in teaching can lead to more engaging lessons that inspire students and help them develop innovative problem-solving skills

(Brown, 2019). Strengthening creative thinking through professional development opportunities focused on innovative teaching methods could enhance this skill.

Lastly, Collaboration (M = 7.20, SD = 0.60) indicates a positive development, with teachers recognizing the value of teamwork and shared learning. Collaboration has been shown to promote a supportive learning environment where teachers exchange ideas, improve practices, and work together to address instructional challenges (Chang & Lee, 2020). The strong score in collaboration demonstrates the effectiveness of LAC sessions in building a culture of professional support and mutual learning.

Overall, the findings suggest that LAC sessions are most effective in enhancing communication and collaboration, with critical thinking showing moderate improvement. However, creativity remains an area for further development. Providing more targeted opportunities for teachers to explore and integrate creative teaching strategies could further enhance their 21st-century skills and improve the overall impact of LAC sessions on instructional practice.

Extent of Mastery on 21st Century Skills of Science Teachers

Table 3 presents the extent of mastery on 21st century skills of science teachers based on four indicators: Critical Thinking, Creativity, Communication and Collaboration. The data includes mean scores and standard deviations for both pre-LACs and post-LACs implementation, using a 4-point Likert scale.

Table 3. *Mean Distribution and Qualitative Description Extent of Mastery on 21st Century Skills of Science Teachers in Terms of 4Cs*

		Pre LACs		*Post LACs*		
Indicator	*N*	*Mean*	*SD*	*Mean*	*SD*	*Description*
Critical Thinking	17	3.06	.39	3.77	0.39	Improved from Good to Very Good
Creativity	17	2.95	.37	3.81	0.38	Improved from fair to Very Good
Communication	17	3.03	.31	3.88	0.38	Improved from Good to Very Good
Collaboration	17	3.05	.43	3.93	0.40	Improved from Good to Very Good
Overall	17	3.02	.38	3.85	0.39	Improved from Good to Very Good

The results reveal significant improvements in 21st-century skills among science teachers after participating in Learning Action Cells (LACs). The most notable increase occurred in Collaboration skills, which rose by 0.88 points (Pre-LACs M = 3.05, SD = 0.43; Post-LACs M = 3.93, SD = 0.40). This substantial gain suggests that LACs effectively promoted teamwork and collective problem-solving. The reduced standard deviation post-LACs further indicates that the improvement was more consistent across teachers. This finding supports Darling-Hammond et al. (2017), who emphasize the importance of collaborative professional learning in enhancing teachers' ability to work together to address instructional challenges.

Similarly, Creativity showed a marked improvement, with a 0.86-point increase (Pre-LACs M = 2.95, SD = 0.37; Post-LACs M = 3.81, SD = 0.38). This improvement reflects a greater capacity among teachers to generate and implement innovative teaching strategies. The slight increase in standard deviation suggests that the improvement was not uniform across all participants. Initially, Creativity had the lowest score, indicating that teachers faced challenges in fostering innovation. However, post-LACs data show a significant boost in this skill, highlighting the program's effectiveness in encouraging creative instructional practices. This finding aligns with Mishra and Koehler's (2006) research, which underscores the role of professional learning communities in promoting creativity and integrating technology into teaching.

The overall gains in Critical Thinking, Creativity, Communication, and Collaboration (Pre-LACs M = 3.02; Post-LACs M = 3.85) emphasize the overall effectiveness of LACs in enhancing key 21st-century skills. The stable standard deviations across the indicators indicate that the improvements were consistent across all participants, aligning with Voogt et al. (2013), who argue that structured teacher training programs play a crucial role in developing these skills.

To further enhance these outcomes, it is recommended that future LAC initiatives continue to focus on fostering creativity and communication skills, which are critical for creating dynamic and engaging learning environments. Expanding LAC programs can help further refine and sustain the growth of these essential competencies among teachers, ultimately benefiting their instructional practices and student engagement (Binkley et al., 2012).

Relationship Between the Level of Practices in LAC Sessions and the Level of Classroom Performance of Science Teachers

Table 4 shows the significant relationship between the level of practices in LAC sessions of science teachers in terms of problem identification, collaborative learning, action planning, and reflection and feedbacking, and their level of classroom performance in terms of critical thinking, creativity, collaboration, and communication.

The correlation analysis revealed significant relationships between Learning Action Cell (LAC) practices and classroom performance indicators of science teachers. The strongest correlation was found between Problem Identification and both Content Knowledge and Pedagogy ($r = 0.872$, $\rho < 0.01$) and Curriculum and Planning ($r = 0.775$, $\rho < 0.01$). This suggests that when teachers effectively identify and address instructional challenges during LAC sessions, they demonstrate stronger skills in both pedagogy and curriculum

development. This finding aligns with Timperley et al. (2007), who emphasize the importance of identifying instructional issues and engaging in collaborative inquiry to enhance teachers' pedagogical content knowledge.

Table 4. *Spearman's Rho Correlation Between the Level of Practices in LAC Sessions and the Level of Classroom Performance of Science Teachers*

LAC Practices Indicator	*Classroom Performance Indicator*	*Correlation Coefficient (r)*	*ρ-value*	*Interpretation*
Problem Identification	Content Knowledge and Pedagogy	0.872	< 0.01	Very Strong Relationship
Problem Identification	Curriculum and Planning	0.775	< 0.01	Very Strong Relationship
Collaborative Learning	Diversity of Learners	0.761	> 0.01	Very Strong Relationship
Action Planning	Curriculum and Planning	0.434	< 0.05	Strong Relationship
Reflection and feedbacking	Assessment and Reporting	0.628	< 0.01	Very Strong Relationship

Similarly, Collaborative Learning showed a strong positive correlation with Diversity of Learners ($r = 0.761$, $\rho < 0.01$), suggesting that teamwork during LAC sessions improves teachers' ability to meet the diverse needs of students. This supports Darling-Hammond et al. (2017), who argue that collaborative learning environments enhance teachers' responsiveness to varied classroom contexts.

The weakest correlation was observed between Action Planning and Curriculum and Planning ($r = 0.434$, $\rho > 0.05$), indicating a moderate, but statistically insignificant, relationship. This suggests that while action planning is a valuable component of LACs, there may be gaps in its integration into curriculum design. Guskey (2002) notes that professional learning programs must include clear implementation strategies to ensure that action plans translate into effective instructional practices.

Overall, these findings underscore the effectiveness of LACs in fostering problem-solving, collaboration, and reflective teaching. However, the weaker correlation between Action Planning and Curriculum and Planning highlights the need for more structured follow-up to ensure that strategies developed during LAC sessions are successfully implemented in instructional planning. Strengthening this connection could lead to more cohesive and impactful curriculum improvements, as suggested by Jensen et al. (2016), who emphasize the importance of sustained, well-structured professional development programs.

Significant Difference Between the 21st Century Skills of Science Teachers Before and After the LAC Session Implementation

Table 5 shows the results of the Wilcoxon Signed Rank Test that were computed to determine whether there was a significant difference between the pretest and posttest scores for 21st century skills in critical thinking, creativity, communication, and collaboration before and after the implementation of Learning Action Cell (LAC) sessions for science teachers.

Table 5. *Wilcoxon Signed Rank Test on the Significant Difference Between the 21st Century Skills of Science Teachers Before and After the LAC Session Implementation*

Indicator	*N*	*Z-Statistic*	*ρ-value*	*Interpretation*
Critical Thinking	17	-3.633	0.000	Significant difference
Creativity	17	-3.650	0.000	Significant difference
Communication	17	-3.648	0.000	Significant difference
Collaboration	17	-3.655	0.000	Significant difference

The results show the highest improvement in Collaboration ($z = -3.655$, $\rho = 0.000$), confirming the effectiveness of Learning Action Cell (LAC) sessions in enhancing teamwork among science teachers. This aligns with Hargreaves and O'Connor (2018), who highlight the role of collaborative teacher networks in promoting professional growth and collective efficacy. Creativity, which had the lowest pre-LAC score, demonstrated a significant increase ($z = -3.650$, $\rho = 0.000$), indicating that LAC sessions were instrumental in fostering innovation in instructional practices. This supports Beghetto and Kaufman (2014), who emphasize the value of reflective and collaborative learning in promoting creative teaching approaches.

Additionally, the significant improvement in Communication ($z = -3.648$, $\rho = 0.000$) underscores the positive impact of LACs on teachers' ability to communicate more effectively. Vangrieken et al. (2017) argue that collaborative professional learning strengthens communication and shared knowledge, improving instructional delivery.

Overall, these findings highlight that LAC sessions are a valuable professional development tool, particularly in improving collaboration, communication, and creativity. To sustain these improvements, future LAC initiatives should focus on structured opportunities for creative problem-solving and continued collaborative learning. This ensures long-term enhancement of teaching competencies (Darling-Hammond, Hyler, & Gardner, 2017; Desimone, 2009). Moreover, as Jensen et al. (2016) note, ongoing, structured professional development leads to sustained improvements in teaching effectiveness, reinforcing the lasting benefits of LAC-based learning.

Significant Relationship Between the Level of Practices in LAC Sessions and the Level 21st Century Skills of Science Teachers

Table 6 shows that Spearman's Rho correlation was conducted to determine the relationship between the level of Learning Action Cell (LAC) practices of science teachers and their 21st-century skills.

Table 6. *Spearman's Rho Correlation Between the Level of Practices in LAC Sessions and the Level of 21st Century Skills of Science Teachers*

LAC Practices Indicator	*21st Century Skills Indicator*	*Correlation Coefficient (rs)*	*ρ-value*	*Interpretation*
Problem Identification	Critical Thinking	0.901	< 0.01	Very Strong Relationship
Problem Identification	Collaboration	0.775	< 0.01	Very Strong Relationship
Collaborative Learning	Communication	0.817	< 0.01	Very Strong Relationship
Collaborative Learning	Collaboration	0.827	< 0.01	Very Strong Relationship
Action Planning	Critical Thinking	0.942	> 0.01	Very Strong Relationship
Action Planning	Creativity	0.832	> 0.01	Very Strong Relationship
Reflection and feedbacking	Critical Thinking	0.812	< 0.01	Very Strong Relationship
Reflection and feedbacking	Collaboration	0.810	< 0.01	Very Strong Relationship

The correlation results revealed significant relationships between LAC practices and 21st-century skills among science teachers. The strongest correlation was found between Action Planning and Critical Thinking (rs = 0.942), indicating that structured planning during LAC sessions is closely tied to teachers' ability to analyze and solve complex problems. However, the statistical insignificance of this relationship suggests the need for further research to validate this connection. This aligns with Fullan and Langworthy (2014), who emphasize that structured professional learning fosters critical thinking and problem-solving in educators.

Both Collaboration and Communication showed strong correlations with Collaborative Learning (rs = 0.827), supporting the idea that teamwork-oriented LAC activities enhance teachers' ability to communicate and collaborate effectively. Vangrieken et al. (2017) argue that teacher collaboration improves communication skills and professional learning outcomes.

These findings highlight the value of LACs in promoting critical thinking, collaboration, and communication. However, the uncertain significance of the Action Planning and Critical Thinking correlation suggests that more structured implementation of LAC sessions is needed to strengthen these benefits. Enhancing planning and problem-solving processes within LACs could improve teachers' higher-order thinking and innovative teaching practices, supporting Darling-Hammond, Hyler, and Gardner's (2017) argument that sustained, well-structured professional learning leads to significant improvements in teaching competencies.

Qualitative Phase

Word Cloud

Perceived Challenges and Benefits on the Implementation of LACs

A word cloud is used in thematic analysis as a visual tool to identify and represent the most frequently used occurring words or phrases in qualitative data. It helps the researchers quickly spot patterns or areas of emphasis within the participant's responses.

Figure 1. *Word Cloud of the Science Teacher Perceived Challenges and Benefits Associated with the Implementation of LAC Sessions*

The word cloud generated from science teachers' responses about their participation in Learning Action Cell (LAC) sessions highlights key themes, including both the benefits and challenges of these professional development initiatives. The five major themes identified are Time Constraints, Collaboration, Professional Growth, Teaching Challenges, and Student-Centered Innovations.

Time Constraints

A common concern among teachers is balancing LAC sessions with their heavy workloads, such as lesson planning, grading, and laboratory preparation. This aligns with Borko (2004), who noted that teachers often struggle to engage in professional development due to time limitations. Desimone (2009) further emphasized that time constraints hinder meaningful participation in collaborative learning. Without adequate time and institutional support, LAC sessions may add to teachers' stress instead of alleviating instructional challenges (Patel et al., 2019).

Collaboration

Collaboration was highlighted as a key benefit of LAC sessions, providing teachers with opportunities to exchange ideas, develop interdisciplinary approaches, and address teaching challenges collectively. This supports the findings of Vangrieken et al. (2017), who stressed that collaboration enhances professional learning and communication. Timperley (2011) also found that collaborative learning communities strengthen problem-solving skills. In science education, collaboration promotes innovation and improved instructional practices (Darling-Hammond et al., 2017).

Professional Growth

Teachers reported that LAC sessions expanded their instructional strategies, introduced innovative teaching methods for complex science topics, and enhanced their overall pedagogical knowledge. Avalos (2011) highlighted the importance of ongoing professional development for improving teaching effectiveness. Garet et al. (2001) also noted that sustained, collaborative professional development has a more significant impact than one-time workshops. LAC sessions contribute to professional growth by exposing teachers to new methods and promoting continuous learning (Brown, 2019).

Teaching Challenges

While beneficial, LAC sessions also present challenges, such as lack of resources, inconsistent facilitator expertise, and discussions that may not always be relevant to science teaching. Smith and Jones (2021) pointed out that effective professional learning communities require structured facilitation and subject-specific focus. In science education, generic discussions may not address the unique challenges of laboratory-based or inquiry-driven instruction (Chang & Lee, 2020). Additionally, limited funding and access to resources can hinder the practical application of strategies discussed in LAC sessions (Patel et al., 2019).

Student-Centered Innovations

One of the most positive impacts of LAC sessions is the improvement in student engagement and learning outcomes. Teachers reported that strategies from LAC sessions helped them design more interactive lessons, leading to increased student participation. This supports Trilling and Fadel (2019), who noted that professional development focused on 21st-century skills leads to student-centered innovations. Darling-Hammond et al. (2017) also emphasized that structured professional learning fosters creativity and enhances student learning experiences.

The word cloud analysis and thematic categorization show that while LAC sessions offer valuable professional development, they also pose challenges. Addressing time constraints, improving facilitation quality, and ensuring resource availability could enhance their effectiveness. Tailoring discussions to the specific needs of science educators may also increase the relevance and applicability of strategies. Future research should explore ways to optimize LAC sessions, ensuring they provide meaningful and sustainable professional growth opportunities for teachers.

Thematic Map

The thematic map visually represents the key themes and their relationships. This thematic map was generated using Python's NetworkX and Matplotlib libraries. These tools allow for the creation of node-link diagrams, which visually represent relationships between key themes and subthemes in a structured format. This thematic map illustrates how the themes connect and influence one another, and provides a structured way to understand the key insights and potential areas for improvement in the future LAC sessions implementation.

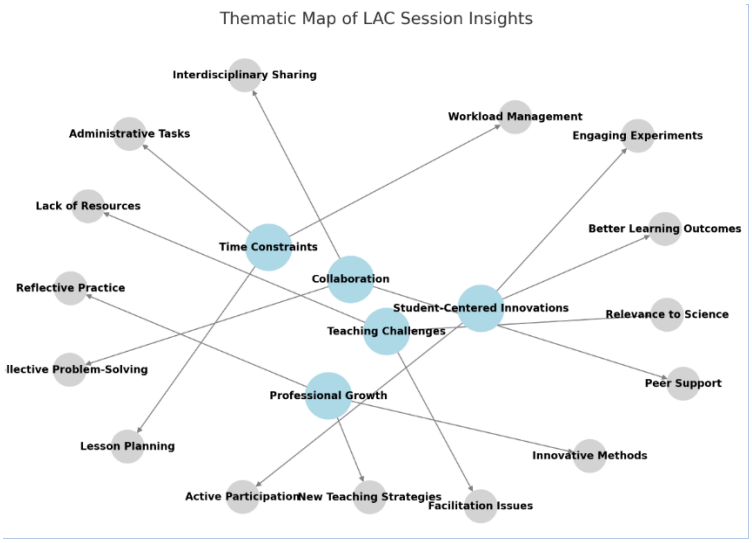


Figure 2. *Thematic Map of Perceived Challenges and Benefits Associated with the Implementation of LAC Sessions*

The thematic map visually illustrates how key factors interconnect, revealing the relationships between Time Constraints, Collaboration, Professional Growth, Teaching Challenges, and Student-Centered Innovations.

The responses from science teachers highlight both the benefits and challenges of LAC session implementation and its impact on science instruction.

Time Constraints

Teachers expressed difficulty balancing LAC sessions with their responsibilities, such as lesson planning, grading, laboratory preparation, and research projects. Six participants noted that time limitations hindered their active participation.

Leonor: "Finding time for LAC sessions amidst a packed teaching schedule is a significant challenge."

Marcela: "Balancing LAC sessions with administrative duties and classroom preparation is overwhelming."

Andres: "Scheduling LAC sessions is stressful, given our limited time for lesson planning and experiments."

Juan: "It's challenging to manage LAC sessions alongside laboratory preparation and grading."

Jose: "With research projects and student mentoring, attending LAC sessions adds to the workload."

Melchora: "Multitasking for Science fairs, lab activities, and LAC sessions can be exhausting."

This finding aligns with Brown (2021), who emphasized that professional learning communities require dedicated time, which many teachers struggle to allocate due to competing responsibilities.

Collaboration

Teachers recognized LAC sessions as valuable platforms for interdisciplinary sharing, peer support, and collaborative problem-solving. Six participants highlighted how teamwork enhanced their professional growth and teaching practices.

Teresa: "LAC sessions provide a platform to share ideas with teachers from different Science fields."

Emilio: "They foster a sense of community and problem-solving among teachers."

Gregorio: "LAC sessions make me feel more confident and supported in tackling classroom challenges."

Jose: "These sessions allow us to voice concerns and seek advice from peers."

Marina: "Collaborating across specializations gave me new ideas for interdisciplinary activities."

Leona: "Sharing teaching practices has improved my lab management skills."

These responses support Johnson and Williams (2021), who emphasized that teacher collaboration fosters a supportive learning environment, enhances professional development, and improves instructional practices.

Professional Growth

LAC sessions contributed to teachers' professional development by introducing innovative teaching strategies, improving instructional methods, and fostering reflective practices. Ten participants shared how the sessions strengthened their teaching competencies.

Antonio: "LAC sessions have broadened my teaching strategies and deepened my knowledge."

Juliana: "Collaborating with peers has exposed me to effective teaching techniques."

Rafael: "I've learned innovative ways to teach complex topics like genetics and chemical reactions."

Maria: "Integrating real-life applications into lessons has made Science more relatable."

Gregorio: "LAC has improved my critical thinking and creativity in lesson planning."

Felipe: "It encourages better communication and teamwork among colleagues."

Juan: "My collaboration and communication skills have improved, benefiting my Science instruction."

Leona: "Critical thinking is enhanced, especially in solving classroom challenges."

Andres: "LAC sessions encourage reflection and refinement of teaching methods."

Melchora: "Constructive feedback from LAC has helped me improve my teaching."

These findings align with Anderson and Martinez (2021), who emphasized that professional learning communities, like LAC, foster teacher growth through innovative strategies and reflective practice.

Teaching Challenges

Despite its benefits, LAC sessions face challenges, including inadequate resources, facilitator expertise, and relevance to science education. Eleven participants emphasized these barriers.

Gregorio: "Some strategies require technology or materials that our school lacks."

Felipe: "Insufficient funding makes it difficult to apply LAC plans in practice."

Leonor: "The lack of Science-specific resources limits direct application of LAC learnings."

Josefa: "The effectiveness of LAC depends on facilitator skills, which vary greatly."

Rafael: "Facilitators may lack Science expertise, limiting the depth of discussions."

Marina: "Sessions aren't always aligned with the Science curriculum."

Emilio: "Discussions sometimes feel more suited for general educators than Science specialists."

Antonio: "Some strategies aren't tailored to advanced topics like in-depth Chemistry lessons."

Teresa: "Sessions often focus on general pedagogy, rather than hands-on Science teaching."

Maria: "Interdisciplinary collaboration sometimes overlooks Science-specific challenges."

Jose: "Resistance to new methods from some colleagues limits LAC's effectiveness."

These concerns align with Smith and Rodriguez (2021), who found that professional learning communities often face barriers related to resource constraints, facilitation quality, and subject-specific alignment.

Student-Centered Innovations

Teachers reported that LAC sessions helped them design engaging lessons, leading to improved student participation and learning outcomes. Four teachers emphasized the benefits of implementing interactive strategies.

Marcela: "LAC strategies have helped me create more engaging lab activities."

Juliana: "Student participation and understanding have improved after implementing LAC ideas."

Josefa: "The strategies I learned have positively impacted student engagement."

Leona: "Reflecting on my teaching through LAC has enhanced instruction quality."

This finding supports Patel et al. (2020), who highlighted that collaborative teacher development programs improve educators' ability to design lessons that foster student engagement and deeper understanding.

Overall

The findings illustrate both the strengths and challenges of LAC sessions in supporting science teachers. While they enhance collaboration, professional growth, and student-centered innovations, issues such as time constraints, facilitation quality, and resource limitations hinder their full potential. Tailoring LAC discussions to address science-specific needs while fostering interdisciplinary collaboration could improve their effectiveness. Future research should explore strategies to optimize LAC sessions, ensuring sustainable and meaningful professional development for science educators.

Word Cloud

Perceived effects of LACs on the 21st century skills of Science Teachers

The word cloud visually represents the five key themes derived from science teachers' reflections on the impact of LAC sessions: Critical Thinking and Problem-Solving, Creativity and Innovation, Communication Skills, Collaboration and Teamwork, and Professional Growth and Continuous Learning. The most frequently mentioned words highlight the significant role of LAC sessions in enhancing teaching strategies, fostering collaboration, and promoting continuous professional development. This visualization underscores how educators benefit from shared learning experiences, innovative approaches, and strengthened skills that contribute to effective science instruction.

The word cloud analysis highlights five key themes emerging from LAC sessions: Critical Thinking and Problem-Solving, Creativity and Innovation, Communication Skills, Collaboration and Teamwork, and Professional Growth and Continuous Learning.

Teachers reported that LAC sessions enhanced their ability to analyze and solve classroom challenges (Facione, 2015; Darling-Hammond et al., 2017), develop creative and student-centered teaching strategies (Beghetto & Kaufman, 2014), and improve communication in explaining science concepts (Garmston & Wellman, 2016). Additionally, collaboration with colleagues broadened

Psych Educ, 2025, **34**(2): 232-247, Document ID:2025PEMJ3253, doi:10.70838/pemj.340207, ISSN 2822-4353

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their perspectives and strengthened teamwork (Hord, 1997; DuFour & Eaker, 1998), while constructive feedback fostered continuous professional growth (Desimone, 2009; Guskey, 2002).

Figure 3. *Word Cloud of the Science Teacher Perceived effects of LAC sessions on the 21st Century Skills*

These findings align with existing research, emphasizing that professional learning communities like LAC sessions play a crucial role in enhancing teachers' instructional practices and 21st-century skills (Schleicher, 2018).

Thematic Map

The thematic map visually represents the five key themes that emerged from teachers' reflections on their Learning Action Cell (LAC) sessions: Critical Thinking and Problem-Solving, Creativity and Innovation, Communication Skills, Collaboration and Teamwork, and Professional Growth and Continuous Learning. These interconnected themes highlight how LAC sessions contribute to teachers' professional development by fostering analytical thinking, encouraging creative teaching methods, improving communication, strengthening teamwork, and promoting continuous learning.

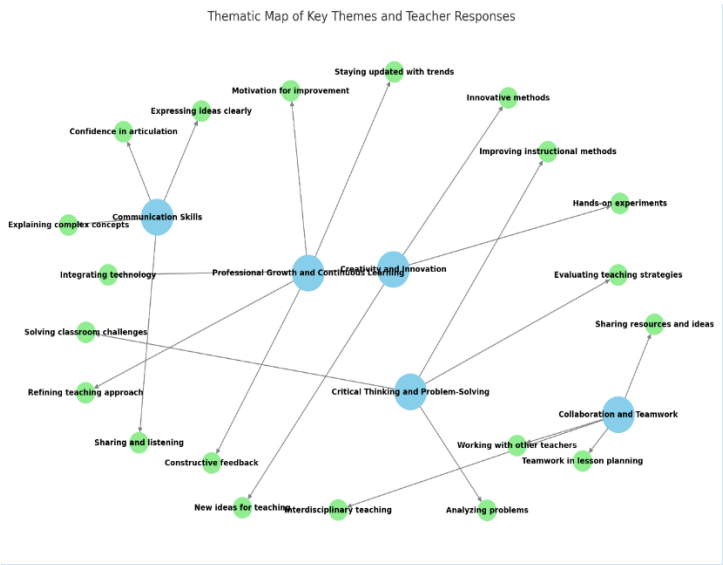

Figure 4. *Thematic Map hematic Map of Perceived effects of LAC sessions on the 21st Century Skills of Science Teachers*

LAC sessions serve as a platform for teachers to analyze instructional challenges and refine their problem-solving abilities. Participants reported that engaging in discussions with colleagues helped them evaluate teaching strategies and develop solutions to classroom difficulties. This finding aligns with Facione (2015), who emphasized that critical thinking enhances educators' ability to make informed decisions and implement effective teaching strategies. Similarly, Darling-Hammond et al. (2017) highlighted that professional learning communities, like LAC sessions, promote reflective thinking and problem-solving, essential for improving instructional effectiveness.

Improved Creativity and Innovation

Juan: "I get new ideas for teaching science lessons creatively. The sessions inspire me to use innovative methods in my classes."

Leona: "The collaborative environment in LAC sessions sparks new ideas for integrating technology and hands-on experiments into my lessons."

Marina: "I have learned to modify and adapt teaching strategies to fit my students' needs, making science lessons more engaging and

interactive."

Teachers also emphasized how LAC sessions inspired them to adopt innovative teaching strategies, integrate technology, and design engaging, student-centered lessons. The importance of creativity in education has been supported by research, with Beghetto and Kaufman (2014) stating that fostering creativity in teaching enhances student engagement and learning outcomes. Furthermore, Fullan and Langworthy (2014) emphasized that teacher collaboration fosters an environment that encourages the development of innovative pedagogical approaches, enabling educators to effectively adapt to diverse classroom needs.

Strengthened Communication Skills

Rafael: "They improve how I express my ideas with peers and students. Sharing and listening during LAC sessions make me a better communicator."

Josefa: "Presenting and discussing my experiences during LAC sessions has improved my confidence in articulating my ideas."

Andres: "I have developed better ways to explain complex science concepts to my students, making lessons clearer and more effective."

The map highlighted communication as a crucial skill enhanced through LAC sessions, as teachers develop their ability to express ideas, articulate complex science concepts, and engage in meaningful discussions with peers. This finding is supported by Garmston and Wellman (2016), who noted that professional learning communities strengthen teachers' communication skills, allowing them to convey concepts more effectively to both colleagues and students. Additionally, Vygotsky's (1978) social learning theory emphasizes the role of dialogue and interaction in knowledge construction, reinforcing the value of LAC sessions in improving teachers' communication abilities.

Effective Collaboration and Teamwork

Gregorio: "LAC sessions teach me how to work effectively with other teachers. We share resources and ideas, which makes collaboration easier."

Teresa: "Working with teachers from different specializations has broadened my perspective and helped me develop interdisciplinary teaching strategies."

Emilio: "LAC sessions encourage teamwork, allowing us to plan lessons together and create better learning experiences for our students."

Collaboration emerged as a dominant theme highlighting the benefits of teamwork in LAC sessions. Participants noted that working with colleagues from different specializations broadened their perspectives and enabled interdisciplinary teaching strategies. This supports Hord's (1997) assertion that collaborative professional learning strengthens teaching practices and promotes a culture of shared responsibility. Similarly, DuFour and Eaker (1998) emphasized that teamwork among educators leads to improved instructional strategies and enhanced student learning experiences.

Professional Growth and Continuous Learning

Jose: "The feedback I receive in LAC has motivated me to continue my teaching strategies."

Melchora: "Receiving constructive feedback from my peers has helped me refine my teaching approach and continuously improve my methods."

Juliana: "LAC sessions have motivated me to pursue further professional development and stay updated with the latest educational trends in science teaching."

Finally, the thematic map underscores the role of LAC sessions in supporting continuous professional development. Teachers reported that receiving constructive feedback from peers motivated them to refine their teaching approaches and stay updated on emerging educational trends. This aligns with the findings of Desimone (2009), who highlighted that ongoing professional development positively influences teachers' instructional practices and student achievement. Furthermore, Guskey (2002) noted that structured collaborative learning opportunities lead to sustained professional growth, as teachers continuously refine their methods based on feedback and shared experiences.

Based on the results and findings, a LAC template model was designed to address the cultural differences among the learners including the indigenous group of Tboli. The Indigenous LAC Template Model was designed to guide science teachers in indigenous communities toward integrating 21st century skills focusing on critical thinking, creativity, communication, and collaboration into their classroom practices.

This model emphasizes culturally responsive teaching methods, ensuring that the unique needs, values, and learning styles of indigenous students are addressed while promoting effective instructional strategies in the areas of content knowledge, pedagogy, diversity of learners, curriculum and planning, and assessment and reporting.

The Indigenous LAC Template Model provides a structured framework that enables science teachers to integrate 21st century skills into their teaching practices while remaining culturally relevant. This model supports the professional development of teachers in indigenous communities by enhancing content knowledge, pedagogy, and classroom practices, ultimately fostering an environment where students are better equipped to succeed in a rapidly changing world.

Conclusions

Based on the results, this study concludes that Learning Action Cell (LAC) sessions may enhance science teachers' instructional effectiveness by fostering reflective teaching, collaboration, and innovation in classroom practices. Teachers who actively engaged in LAC sessions demonstrated improvements in content knowledge, pedagogy, and curriculum planning, which may contribute to more consistent and effective instructional strategies.

The findings suggest that LAC sessions may also support the development of 21st-century skills, particularly collaboration and creativity, with observed improvements in critical thinking and communication. However, challenges in structured problem identification and action planning indicate a need for more targeted frameworks to help teachers translate identified challenges into concrete solutions.

Despite limitations such as time constraints, resource availability, and variations in applicability across science disciplines, LAC sessions may serve as a valuable professional learning tool, promoting continuous growth and adaptability in teaching practices. The study further suggests that structured collaborative learning and reflective discussions may strengthen teachers' confidence in implementing student-centered and culturally responsive strategies.

Future research may explore refinements in problem-solving mechanisms and action planning within LAC sessions to maximize their effectiveness. Strengthening these areas may lead to greater pedagogical impact and better integration of 21st-century skills in science education, particularly in diverse learning environments such as indigenous communities.

References

Anderson, T., & Martinez, L. (2021). The role of professional learning communities in fostering teacher growth. Educational Research Journal, 35(2), 45–67.

Angrosino, M. (2007). Doing ethnographic and observational research. SAGE Publications.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. Teaching and Teacher Education, 27(1), 10–20.

Bandura, A. (1977). Social learning theory. Prentice-Hall.

Beghetto, R. A., & Kaufman, J. C. (2014). Classroom contexts for creativity. High Ability Studies, 25(1), 53–69.

Beghetto, R. A., & Kaufman, J. C. (2014). Teaching for creativity in the Common Core classroom. Teachers College Press.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first-century skills. In P. Griffin, B. McGaw, & E. Care (Eds.), Assessment and teaching of 21st-century skills (pp. 17–66). Springer.

Blaine, A. (2018). Interaction and presence in the virtual classroom: An analysis of the perceptions of students and teachers. Journal of Interactive Learning Research, 29(3), 307–329.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. Educational Researcher, 33(8), 3–15.

Brayboy, B. M. J., & Castagno, A. E. (2008). How might Native science inform "traditional" science education? Cultural Studies of Science Education, 3(3), 731–750.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101.

Brown, C. (2019). Teacher collaboration and professional development: A critical perspective. Educational Review, 71(5), 517–531.

Brown, J. (2021). Time constraints and teacher participation in professional learning communities. Journal of Teacher Development, 28(4), 112–129.

Bybee, R. W. (2010). The BSCS 5E instructional model: Personal reflections and contemporary implications. Science and Children, 48(2), 56–58.

Cai, X., Kim, M., & Rudd, P. (2022). Critical thinking development in teacher education programs: A systematic review. Teaching and Teacher Education, 108, 103531.

Chang, Y., & Lee, J. (2020). Professional learning communities as a mechanism for teacher growth: A meta-analysis. Journal of Education Research, 113(4), 291–305.

Chang, Y. L., & Lee, G. (2020). Professional learning communities: A review of research. Journal of Educational Change, 21(2), 173–199.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Cohen, L., Manion, L., & Morrison, K. (2018). Research methods in education (8th ed.). Routledge.

Cohen, R. J., Swerdlik, M. E., & Sturman, E. D. (2013). Psychological testing and assessment: An introduction to tests and measurement (8th ed.). McGraw-Hill.

Craft, A. (2019). Creativity and education futures: Learning in a digital age. Trentham Books.

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). SAGE Publications.

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). SAGE Publications.

Creswell, J. W., & Plano Clark, V. L. (2011). Designing and conducting mixed methods research (2nd ed.). SAGE Publications.

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five approaches (4th ed.). SAGE Publications.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). Effective teacher professional development. Learning Policy Institute.

Department of Education (DepEd). (2016). DepEd Order No. 35, s. 2016: The learning action cell as a K to 12 basic education program school-based continuing professional development strategy for the improvement of teaching and learning. https://www.deped.gov.ph/2016/06/07/do-35-s-2016/

Department of Education. (2016). DO 55, s. 2016 – Policy guidelines on the national assessment of student learning for the K to 12 basic education program. Department of Education, Republic of the Philippines.

Denzin, N. K. (2012). Triangulation 2.0. Journal of Mixed Methods Research, 6(2), 80–88.

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. Educational Researcher, 38(3), 181–199.

DeVellis, R. F. (2017). Scale development: Theory and applications (4th ed.). SAGE Publications.

DuFour, R. (2004). What is a professional learning community? Educational Leadership, 61(8), 6–11.

DuFour, R., & Eaker, R. (1998). Professional learning communities at work: Best practices for enhancing student achievement. Solution Tree Press.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, 5(1), 1–4.

Facione, P. A. (2015). Critical thinking: What it is and why it counts. Insight Assessment.

Field, A. (2018). Discovering statistics using IBM SPSS statistics (5th ed.). Sage.

Fisher, A. (2015). Critical thinking: An introduction. Cambridge University Press.

Fullan, M. (2016). The new meaning of educational change (5th ed.). Teachers College Press.

Fullan, M., & Langworthy, M. (2014). A rich seam: How new pedagogies find deep learning. Pearson.

Gall, M. D., & Borg, W. R. (2007). Educational research: An introduction (8th ed.). Pearson.

Garmston, R. J., & Wellman, B. M. (2016). The adaptive school: A sourcebook for developing collaborative groups (3rd ed.). Rowman & Littlefield.

Gay, G. (2018). Culturally responsive teaching: Theory, research, and practice (3rd ed.). Teachers College Press.

Guskey, T. R. (2002). Professional development and teacher change. Teachers and Teaching, 8(3), 381–391.

Hargreaves, A., & Fullan, M. (2012). Professional capital: Transforming teaching in every school. Teachers College Press.

Hord, S. M. (1997). Professional learning communities: Communities of continuous inquiry and improvement. Southwest Educational Development Laboratory.

Johnson, D. W., & Johnson, R. T. (2018). Cooperative learning and academic achievement. Contemporary Educational Psychology, 58, 1–10.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. Educational Researcher, 33(7), 14–26.

Krueger, R. A., & Casey, M. A. (2015). Focus groups: A practical guide for applied research (5th ed.). SAGE Publications.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge University Press.

Mann, H. B., & Whitney, D. R. (1947). On a test of whether one of two random variables is stochastically larger than the other. Annals of Mathematical Statistics, 18(1), 50–60. https://doi.org/10.1214/aoms/1177730491

Merriam, S. B. (2009). Qualitative research: A guide to design and implementation. Jossey-Bass.

Moustakas, C. (1994). Phenomenological research methods. Sage.

OECD. (2018). The future of education and skills: Education 2030. Organisation for Economic Co-operation and Development.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and Policy in Mental Health and Mental Health Services Research, 42(5), 533–544.

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. Health Services Research, 34(5), 1189–1208.

Schleicher, A. (2018). World class: How to build a 21st-century school system. OECD Publishing.

Teddlie, C., & Tashakkori, A. (2009). Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences. Sage.

Timperley, H. (2011). Realizing the power of professional learning. McGraw-Hill Education.

Trilling, B., & Fadel, C. (2009). 21st-century skills: Learning for life in our times. Jossey-Bass.

Vangrieken, K., Meredith, C., Packer, T., & Kyndt, E. (2017). Teacher communities as a context for professional development: A systematic review. Teaching and Teacher Education, 61, 47–59.

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. Teaching and Teacher Education, 24(1), 80–91.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Affiliations and Corresponding Information

Jeanly S. Jaleco
T'boli National High School
Department of Education – Philippines

Christine P. Abo, PhD
Sultan Kudarat State University – Philippines