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DEVELOPMENT AND VALIDATION OF CHEMISTRY STUDENTS' PEER-ASSISTED RESOURCE KNOWLEDGE-BOOK (CHEM-SPARK)

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Abstract

Introduction

The study addressed a critical shortage of specialized instructional materials for science 8 (General Chemistry) that are adapted for peer tutoring and classroom remediation, with few existing resources that align with essential learning competencies. To fill this gap, the CHEM-SPARK was developed, basing its content foundation on the least-learned concepts identified among Grade 8 students in a public high school in the City of Malolos. Following initial revisions, the CHEM-SPARK was rated by six teacher-experts, who awarded it an exceptional overall mean rating of Excellent ($\bar{X}$ = 4.90) across all criteria. A subsequent formal review by the School Quality Assurance Team (SQAT) confirmed its quality, validating that the CHEM-SPARK passed all criteria in the LRMDS evaluation tool, scoring highly in content (27.75), format (71), presentation and organization (20), and accuracy and up-to-datedness (24). The validated CHEM-SPARK was then utilized over seven weeks in both face-to-face (18 tutor-tutee pairs) and online (19 pairs) peer tutoring sessions. Feedback from face-to-face tutors ($\bar{X}$ = 4.88), online tutors ($\bar{X}$ = 4.84), face-to-face tutees ($\bar{X}$. =4.57), and online tutees ($\bar{X}$ = 4.68) was overwhelmingly positive. Tutors reported growth in valuable 21st-century skills (e.g., leadership and communication), while both groups affirmed the CHEM-SPARK's effectiveness for conceptual understanding and exam preparation. These findings collectively demonstrate the CHEM-SPARK's high pedagogical quality and its efficacy as a validated instructional resource for enhancing student engagement and achieving mastery of foundational Chemistry concepts, making it a sustainable resource for peer tutoring in classroom remediation programs.

Keywords: *General Chemistry, Instructional Material, Peer Tutoring, Remediation Program, Quality Assurance*

Introduction

The Department of Education (DepEd), a learner-centered public institution in the Republic of the Philippines, ensures that all school policies, programs, and activities are child-centered, gender-fair, and age- and culture-appropriate. Its goal is to holistically develop Filipino learners with 21st-century skills. DepEd also guarantees the promotion and protection of Filipino learners' rights to quality, equitable, and culture-based education. The department further ensures that every learner completes primary quality education with the necessary competencies and skills for higher education and is prepared for the world of work and entrepreneurship (DepEd, 2013).

There are directives issued by DepEd that demonstrate its commitment to ensuring the successful completion of high-quality primary education for all learners. These directives serve as guidelines for educators like me, emphasizing the need to implement intervention programs to help underperforming students advance to the next grade level and ensure their smooth progression through the educational hierarchy.

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One such directive is DepEd Order No. 8, issued in 2015 and titled "Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program." This order emphasizes the importance of teachers employing appropriate instructional strategies to support learners requiring remediation or enrichment.

Additionally, DepEd Order No. 13, issued in 2018 and titled "Implementing Guidelines on the Conduct of Remedial and Advancement Classes During Summer for the K to 12 Basic Education Program," mandates educators to proactively plan and design immediate instructional interventions aimed at facilitating learners' seamless transition to the next grade level. These DepEd directives reaffirm the crucial role of teachers in engaging students and providing remediation opportunities to address any learning gaps or subject area deficiencies they may have.

In response to the challenges brought by the pandemic, the Department of Education also released further guidelines to support distance learning. DepEd Memorandum DM-CI-2020-00162 encouraged the use of various learning materials, including textbooks, self-learning modules, videos, audio lessons, activity sheets, and interactive e-materials. These were intended to help learners understand their lessons even without face-to-face classes. Students were given a set amount of time to complete their tasks, with those needing help receiving remediation and those who finished early receiving enrichment activities. Teachers, specialists, and supervisors were also allowed to create additional materials, provided they were aligned with the Most Essential Learning Competencies (MELCs).

Despite these efforts and the use of various instructional methods in the researcher's classroom discussions and activities, learners' academic performance remains below satisfactory expectations. Previous studies (Reyes, 2015; Bernardo, 2014; and Dongallo, 2013) have substantiated that inadequate teaching methods and a lack of instructional materials contribute to this problem.

Recent international assessments also reflect these challenges. The results of the 2022 Programme for International Student Assessment (PISA) reported by the Organization for Economic Co-operation and Development (OECD, 2023) revealed that only 23 percent of Filipino students reached at least Level 2 proficiency in science. This outcome shows no significant improvement since 2018 and remains far below the OECD average of 76 percent of students achieving the same level. These findings highlight the continuing need for effective learning tools and strategies to help Filipino learners, especially in science, meet global standards.

As curriculum demands increase while instructional resources remain insufficient, many dedicated educators grapple with the daunting task of providing high-quality education to their students within their classrooms.

In a real-life classroom scenario, particularly in public schools, teachers often face the formidable challenge of instructing and ensuring mastery of lesson competencies for a sizeable group of learners, ranging from 40 to 70 students. This challenge becomes especially pronounced when working with learners identified as low achieving.

During the researcher's nine-year tenure as an educator in a public school, a prevailing observation has been the persistence of traditional teaching methodologies among teachers. In this traditional paradigm, educators assume the exclusive role of imparting knowledge and expertise to their students. They exercise autonomy in selecting what they believe are the most effective classroom instructional strategies and use a variety of instructional materials to align with their students' interests and accommodate their learning abilities.

Furthermore, the researcher has noted a significant improvement in student performance when instructional materials are tailored to specific learner profiles. It is imperative that teachers possess a comprehensive understanding of each learner's unique needs and educational objectives. A group of students comprises individuals with distinct requirements and aptitudes, necessitating tailored instructional approaches.

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Proficiency in discerning how students learn most effectively and in employing appropriate teaching strategies enables learners to fully harness their educational potential.

Learning can also be enhanced through peer interactions. When learners have close friends who support them in the classroom, their attitudes towards school and learning tend to be more positive. These friendships contribute to learners' emotional and moral development, providing valuable opportunities to practice essential social skills. Learners engage in exercises that involve managing their emotions and responding to the emotions of those around them, fostering valuable personal growth. In essence, the presence of friends greatly benefits learners (Contreras, 2017).

Furthermore, there are numerous social and behavioral advantages associated with friendships. According to the National Education Association (Anderson, 2017; Gallagher, 2015), as outlined in its research on best practices in education, peer tutoring extends learners' understanding beyond the confines of the traditional classroom. Participants in peer tutoring programs acquire knowledge, attain specific skills, improve their relationships with peers, develop personal and social skills, and experience heightened motivation.

Camerlengo (2012) characterizes peer tutoring as an educational approach in which one learner imparts knowledge to another in a subject where the tutor possesses greater expertise than the tutee. Peer tutoring typically occurs when a teacher identifies a student who excels at understanding specific concepts or skills and is actively engaged in class, and tasks them with assisting classmates who are encountering challenges in a particular subject area. The researcher views peer tutoring as a promising instructional strategy that can enhance learners' performance in each subject with minimal teacher intervention and supervision.

This strategy, as demonstrated in the studies of Moliner, Alegre, and Lorenzo-Valentín (2022) and Zhang (2024), provides high-achieving students with valuable opportunities to share their knowledge and assist peers in developing the competencies and skills necessary for progression to the next grade level. As a simple yet effective instructional approach, peer tutoring holds considerable potential to address the diverse academic and social needs of learners with varying abilities in a traditional classroom setting, without diminishing the learning experience of other students.

This research focuses on science 8 (General Chemistry) instruction, with a primary goal of addressing the persistent challenges Grade 8 students face in acquiring the essential competencies mandated by the Department of Education. Over the years, a significant number of the researcher's students have had difficulty understanding Chemistry lessons, resulting in subpar performance and lower grades. Consequently, many students have progressed to higher grade levels with only a rudimentary grasp of fundamental Chemistry concepts, hindering their ability to succeed in subsequent, more advanced Chemistry courses.

These educational obstacles were exacerbated by the pandemic's unforeseen disruptions, which compelled students to adapt to distance learning for an extended period. Given these circumstances, this research endeavors to bridge a crucial gap in Chemistry education by developing a Chemistry Workbook, CHEM-SPARK, specifically designed for a peer-tutoring classroom remediation program. This innovative approach aims to empower learners to master the concepts of science 8 (General Chemistry) comprehensively.

Although the CHEM-SPARK's content was initially benchmarked against the K to 12 Most Essential Learning Competencies (MELCs) (DepEd, 2020), its core innovation—the integrated peer tutoring strategy—and its main objective addressing the core competencies necessary for foundational scientific literacy, secures its continuing academic and practical relevance and alignment with the MATATAG Curriculum's goals for deep conceptual understanding and skill mastery in science.

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The transition to the MATATAG Curriculum is anchored in theoretical and philosophical foundations, such as Vygotsky's Zone of Proximal Development (ZPD) (DepEd, 2023). This framework places significant emphasis on two key areas: the effective development of a durable understanding of foundational knowledge and the cultivation of essential 21st-century skills, including teamwork and collaboration. By purposefully incorporating the peer tutoring strategy, which models learning as co-construction guided by a more knowledgeable peer, the CHEM-SPARK directly addresses and supports these comprehensive learning objectives. Consequently, the material maintains its pedagogical appropriateness and utility, effectively reinforcing both the cognitive mastery of chemistry and the vital interpersonal skills integral to the evolving educational framework. By addressing this pressing need and leveraging the potential of peer tutoring, this research promises to make a substantial contribution to the field of education, especially in enhancing the educational outcomes of learners facing diverse challenges in Chemistry instruction.

Statement of the Problem

The general problem of this study is to determine "How the CHEM-SPARK (CHEMistry Students' Peer-Assisted Resource Knowledge) can be developed."

Specifically, the study sought to answer the following questions:

1. What standard procedures are followed in developing the CHEM-SPARK?
2. How did the teacher-experts evaluate the developed CHEM-SPARK in terms of:
   2.1. objectives;
   2.2. contents;
   2.3. language and format;
   2.4. coverage of the activity;
   2.5. manner of presentation;
   2.6. usefulness and;
   2.7. acceptability?
3. How may the School Quality Assurance Team (SQAT) evaluate the developed CHEM-SPARK in terms of:
   3.1. content;
   3.2. format;
   3.3. presentation and organization and;
   3.4. accuracy and up-to-datedness of information?
4. How do students evaluate their experience and appreciation after using the CHEM-SPARK during peer tutoring?

Methodology

This study employed a convergent mixed-methods design, integrating quantitative and qualitative approaches to evaluate the CHEM-SPARK remediation program. The development of the instructional material followed the Borg and Gall (1983) Research and Development (R&D) model. Quantitative data addressed teacher-expert validation and learner perceptions, while qualitative data—gathered through document analysis, Focus Group Discussions (FGD), and member checking—explored development procedures and participant experiences. Data integration was achieved via a joint display approach using a Data Integration Matrix (Fetters et al., 2013).

Using purposive sampling, the study involved Grade 8 learners from a public secondary school in the City of Malolos during School Year 2021–2022. The participants were classified into two groups: tutors and tutees. The tutors (n = 37) were learners who obtained "Outstanding" grades ranging from 90 to 100 and met the Minimum Proficiency Level (MPL), while the tutees (n = 37) were learners with grades of 80 and below who did not meet the MPL. These participants were paired and assigned to two learning modalities: limited face-to-face instruction, involving 18 tutor–tutee pairs, and online instruction, involving 19 pairs. In addition, the

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instructional material used in the study was validated by two groups of evaluators, namely six teacher-experts with teaching experience ranging from 13 to 31 years and a four-member School Quality Assurance Team (SQAT).

The study utilized four primary research instruments. First, the Teacher-Experts' Questionnaire, adapted from Cabuhat (2014), was used to evaluate the objectives, content, and usability of the material and demonstrated high internal consistency (Cronbach's $\alpha = 0.87$). Second, the Learning Resources Management and Development System (LRMDS) Evaluation Rating Sheet, based on DepEd Order No. 76, s. 2011, served as the tool for formal quality assurance. Third, the Learner Experience Questionnaires were employed to capture the experiences of both tutees and tutors; the tutee questionnaire was adapted from Menezes et al. (2016) with a reliability coefficient of $\alpha = 0.88$, while the tutor questionnaire was adapted from Cofer (2020) and yielded a Cronbach's alpha of 0.769. Lastly, a Focus Group Discussion (FGD) guide and a member-checking protocol, consisting of validated sets of questions, were used to gather qualitative reflections and ensure interpretive validity, consistent with the framework of McKim (2023).

The researcher identified the least-learned competencies in science 8 to inform the CHEM-SPARK content. After obtaining ethical clearance and parental consent, the material underwent two rounds of expert validation. Following the remediation program, FGDs were conducted with 24 selected participants (12 tutors, 12 tutees) nine months post-intervention. Member checking was conducted 11 months later to confirm the accuracy of the qualitative transcripts and interpretations.

Quantitative data were analyzed using mean and standard deviation to assess validity and consistency. The Intraclass Correlation Coefficient (ICC) was applied to determine inter-rater reliability among experts (Koo & Li, 2016). Qualitative data from FGDs were analyzed using Braun and Clarke's (2006) Inductive Thematic Analysis. Coding followed Saldaña's (2013) framework, employing descriptive, process, in vivo, emotion, and magnitude coding to bridge qualitative narratives with statistical trends.

Results And Discussion

I. Development of the CHEM-SPARK

The development of CHEM-SPARK followed a modified Borg and Gall (1983) Research and Development (R&D) model. To ensure practicality within resource constraints, the original ten stages were condensed into a five-stage systematic process: (1) Preparatory, (2) Validation, (3) Revision, (4) Tryout, and (5) Finalization (Alpina et al., 2021; Untoroseto & Triayudi, 2023).

1. Preparatory Stage: Needs Assessment and Design

The content of CHEM-SPARK was aligned with the DepEd Most Essential Learning Competencies (MELCs) for Grade 8 General Chemistry. Based on the 2020–2021 School-Based Assessment Reports, four "least learned" competencies were prioritized, including subatomic particles, periodic table behavior, physical changes, and the particle nature of matter.

A Workbook Blueprint Matrix was utilized to ensure constructive alignment between objectives, peer-tutoring strategies, and assessments. This structured mapping is critical for increasing student engagement and knowledge transfer (Moreno-Guerrero et al., 2020).

2. Validation Stage

The CHEM-SPARK underwent a rigorous validation process involving teacher-experts and the School Quality Assurance Team (SQAT) to establish content validity and pedagogical soundness. Evaluators used the DepEd-prescribed LRMDS Evaluation Rating Sheet to assess the material's objectives, content, language, and format. Quantitative results indicated high acceptability, with all items achieving a mean score above 3.35 on a 5-point

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Likert scale. Qualitatively, experts emphasized the need for better visual appeal and the integration of local context. Consequently, the material was enhanced by incorporating illustrations for visual learners and contextualizing examples within Filipino culture and heritage to improve learner relatability and engagement.

3. Revision Stage

The revision process was an iterative, three-cycle progression informed by expert feedback, student Focus Group Discussions (FGDs), and member-checking. Initial revisions focused on structural formatting and on aligning activities with the Workbook Blueprint Matrix. Based on student feedback during the tryout phase, the researcher incorporated interactive, game-based activities (e.g., Unit 3, Activity 2E) and added formative drills to strengthen mastery. A significant addition was the "CHEM-SPARK Highlights" section at the end of each activity, which provided a concise synthesis of key concepts. Final refinements were made following the research panel's defense, including technical nomenclature adjustments—such as adopting "weak/strong" descriptions of molecular attraction—and the addition of specific instructional guides for tutors.

4. Tryout Stage: Implementation via Peer Tutoring

The CHEM-SPARK was implemented over seven weeks involving 37 student pairs across online (n=19) and face-to-face (n=18) modalities. The implementation utilized directive and nondirective tutoring styles (Briggs, 2013), allowing for differentiated support. Tutors provided immediate feedback during a structured cycle of reading, independent answering, and concept explanation.

5. Finalization

The final version was refined based on panel recommendations, including technical nomenclature adjustments (e.g., using "weak/strong" to denote molecular attraction) and the addition of specific visual diagrams illustrating the phases of matter. The final product stands as a validated, MELC-aligned instructional material optimized for peer-mediated remediation.

II. Teacher-Experts' Validation of the CHEM-SPARK

Table 1

Summary of Teacher-Experts' Evaluation of the CHEM-SPARK

Criteria	Mean	SD	ICC	Verbal Interpretation
A. Objectives	4.90	0.32	0.80	*Excellent*
B. Contents	5.00	0.00	1.00	*Excellent*
C. Language and Format	4.80	0.48	0.84	*Excellent*
D. Activities	4.94	0.24	0.99	*Excellent*
E. Manner of Presentation	4.83	0.38	0.67	*Excellent*
F. Usefulness	4.93	0.25	0.97	*Excellent*
G. Acceptability	4.93	0.25	0.99	*Excellent*
Grand Mean	**4.90**			***Excellent***

Note. SD = Standard Deviation; ICC = Intraclass Correlation Coefficient.

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Table 1 presents the summary of the mean scores from teacher-experts' evaluations of CHEM-SPARK. The criterion with the lowest mean score was language and format, rated at 4.80 and interpreted as excellent. This was followed by the manner of presentation, rated at 4.83, the objectives at 4.90, the usefulness at 4.93, the acceptability at 4.93, and the activities at 4.94, all interpreted as excellent. Finally, content received a perfect rating of 5.00, also interpreted as excellent.

These findings align with Ayyıldız, Tarhan, and Gil (2022), who reported that well-designed instructional resources significantly improve chemistry learning outcomes and student achievement. CHEM-SPARK attained an overall grand mean of 4.90, confirming its excellent quality and effectiveness in enhancing student engagement and academic outcomes during peer-assisted classroom remediation.

III. School Quality Assurance Team's (SQAT) Validation of the CHEM-SPARK

Table 2

Summary of Total Points and Verbal Interpretations of the SQAT Evaluation of the CHEM-SPARK

Criteria	Total Points	Verbal Interpretation
A. Content	27.75	*Passed*
B. Format	71.00	*Passed*
C. Presentation and Organization	20.00	*Passed*
D. Accuracy and Up-to-datedness of Information	24.00	*Passed*

Note. Total points represent the aggregate scores from the Secondary Quality Assurance Team (SQAT) evaluation.

The results of the SQAT validation of the CHEM-SPARK used in peer tutoring classroom remediation for Chemistry are summarized in Table 2. The workbook's content obtained 27.75 points, while its format received 71 points, both interpreted as passed. Likewise, its presentation and organization of ideas earned 20 points, and the accuracy and up-to-datedness of the information earned 24 points, both also rated as passed. These consistently high results highlight the workbook's strong academic quality and effective instructional design. The uniform "passed" ratings confirm that CHEM-SPARK is pedagogically sound, visually organized, and scientifically accurate, making it a dependable resource for classroom use.

This overall performance aligns with Reigeluth's (2012) Instructional Theory, which emphasizes the systematic sequencing and organization of learning materials to ensure clarity and progression of knowledge. It also supports Tomlinson's (2001) Principles of Materials Development, which advocate that effective materials should balance accuracy, aesthetics, and learner-centered design. Moreover, through Vygotsky's (1978) lens, the workbook's structured, peer-assisted framework enables learners to construct understanding collaboratively within their Zone of Proximal Development, while Johnson and Johnson's (2018) Social Interdependence Theory reinforces the workbook's promotion of cooperative engagement and shared responsibility among peers.

Consistent with Rodriguez (2023), well-designed, pedagogically sound, and well-structured instructional materials can meet learners' needs. Similarly, Butron (2021) found that expertly developed K–12 chemistry materials with high validation reliability promote learner engagement, classroom acceptability, and increased student interest. The strong SQAT validation results for CHEM-SPARK align with these findings, supporting its

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readiness for classroom implementation as a validated, reliable, and pedagogically aligned resource to enhance Science 8 (General Chemistry) learning through structured peer-assisted remediation.

Table 3

SQAT's Validation Results on Identified Desirable Values and Traits Applied to the CHEM-SPARK

Item	Frequency	Percentage
5.1 Pride in Being a Filipino	0	0.00
5.2 Scientific Attitude and Reasoning	4	100.00
5.3 Desire for Excellence	4	100.00
5.4 Love for Country	0	0.00
5.5 Helpfulness/ Teamwork/ Cooperation	4	100.00
5.6 Unity	2	50.00
5.7 Desire to Learn New Things	4	100.00
5.8 Honesty and Trustworthiness	2	50.00
5.9 Ability to Know Right from Wrong	4	100.00
5.10 Respect	1	25.00
5.11 Critical and Creative Thinking	4	100.00
5.12 Productive Work	4	100.00
5.13 Other: (Please Specify)	0	0.00

Note. Frequency represents the SQAT members (n = 4) who identified the integrated values or traits within the CHEM-SPARK material.

Table 3 shows the sought-after values available in CHEM-SPARK. None of the four (4) SQAT validators found values of pride in being a Filipino and love for the country in the workbook. Additionally, one (1) out of the four (4) validators from the SQAT found the presence of the values of respect in the workbook. Moreover, the values of honesty and trustworthiness were identified by two (2) of the four (4) SQAT validators. Also, three (3) out of the four (4) SQAT validators found evidence of critical and creative thinking in the workbook. Furthermore, four (4) out of the four (4) validators from the SQAT found the following values embedded in the workbook, such as scientific attitude and reasoning, desire for excellence, helpfulness, teamwork, cooperation, desire to learn new things, ability to know right from wrong, and productivity in the workbook.

The pattern suggests that, although cultural values are not explicitly stated, the CHEM-SPARK activities strongly promote scientific discipline, cooperation, and reflective learning. In Unit 1, Activity 1, Matter and Its Properties, learners identify samples, distinguish properties, and justify their answers, while in Unit 2, Activity 1, Changes in Matter, learners classify changes and list evidence for their classifications. During peer tutoring sessions, the tutee first attempts the activity, and the tutor then checks answers, offers corrective feedback, and guides reasoning, which encourages accuracy, honesty, persistence, and shared problem solving. These structured, scaffolded interactions require learners to observe carefully, explain their thinking, and support one another, thereby cultivating responsibility and cooperative ethics within a scientific context.

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The observed values are consistent with Vygotsky's (1978) Social Development Theory and Johnson and Johnson's (2018) Social Interdependence Theory, which emphasize that social interaction and collaboration enhance both cognitive growth and moral development. The structured sequencing of tasks follows Reigeluth's (1999) Instructional Theory, guiding learners from guided inquiry to independent reasoning, while the clarity and engaging layout embody Tomlinson's (2001) Principles of Materials Development, ensuring motivation and learner comfort.

Likewise, Borillo (2025) emphasized that instructional materials should not only enhance academic performance but also cultivate essential qualities among learners, such as productivity, scientific attitude, and sound reasoning. By strengthening these specific traits in the revised edition based on research panel recommendations, the CHEM-SPARK effectively integrates values formation with conceptual understanding through authentic, peer-assisted learning experiences.

IV. Experiences of Learners Using the CHEM-SPARK in the Peer Tutoring Classroom Remediation Program

Table 4

Tutors' Perceptions in Face-to-Face and Online Peer Tutoring Sessions Using the CHEM-SPARK

Domain	Face-to-Face			Online		
	Domain SD	**Grand Mean**	**Verbal Interpretation**	**Domain SD**	**Grand Mean**	**Verbal Interpretation**
Personal and Interpersonal Development	0.44	4.81	Very Low Variability, Positive	0.39	4.77	Very Low Variability, Positive
Cognitive and Academic Development	0.36	4.83	Very Low Variability, Positive	0.38	4.83	Very Low Variability, Positive
Mentorship and Institutional Support	0.00	5.00	Very Low Variability, Positive	0.00	5.00	Very Low Variability, Positive
Workbook Design and Usefulness	0.24	4.93	Very Low Variability, Positive	0.29	4.87	Very Low Variability, Positive
Overall	**0.35**	**4.88**	**Very Low Variability, Positive**	**0.31**	**4.84**	**Very Low Variability, Positive**

Note: SD-Standard Deviation

The findings in Table 4 indicate that tutors evaluated CHEM-SPARK very positively across both peer tutoring modalities. In the face-to-face setting, the results showed an overall mean of 4.88 with a standard deviation of 0.35, while the online modality obtained a mean of 4.84 with a standard deviation of 0.31. The consistently very low variability across responses reflects strong agreement among tutors, suggesting that the workbook, along with the peer tutoring framework it supports, proved both reliable and effective in enhancing their tutoring experience.

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In terms of Personal and Interpersonal Development, tutors rated both face-to-face (M = 4.81, SD = 0.44) and online (M = 4.77, SD = 0.39) modalities very positively. This aligns with Vygotsky's Social Development Theory, which posits that learning is mediated through social interaction and collaboration (Cherry, 2024). The peer tutoring sessions using CHEM-SPARK provided structured opportunities for tutors to practice leadership, empathy, and communication skills through guided activities and discussion prompts, strengthening their interpersonal competencies.

For Cognitive and Academic Development, both face-to-face and online sessions achieved equal ratings (M = 4.83). This indicates that tutors not only reinforced their own understanding but also developed deeper mastery by teaching their peers. This result is supported by Reigeluth's Instructional Theory, which highlights the value of scaffolding and practice opportunities in promoting learner mastery (Twyman, 2021). The structured exercises, problem sets, and illustrations in CHEM-SPARK facilitated a step-by-step approach to tutoring, ensuring that tutors could explain concepts effectively while consolidating their own knowledge.

The highest rating was in Mentorship and Institutional Support (M = 5.00, SD = 0.00) in both modalities, indicating complete agreement that the program provided sufficient support structures. This finding reflects Social Interdependence Theory, which emphasizes the role of cooperative learning environments in fostering responsibility and mutual support (Johnson & Johnson, 2018). The consistent provision of clear guidance and collaborative frameworks in the CHEM-SPARK activities contributed to this outcome, ensuring that tutors felt adequately equipped and supported.

The domain of Workbook Design and Usefulness received very high ratings (face-to-face M = 4.93; online M = 4.87), reflecting CHEM-SPARK's strength as a learning resource grounded in Tomlinson's Principles of Materials Development, which emphasize clarity, contextual relevance, and learner engagement (Brown & Raza, 2020). Its guided activities, illustrations, and organized layout enabled tutors to confidently use it as both a teaching aid and reinforcement material, confirming its dual role as an instructional guide and peer learning resource. The intuitive design significantly reduced the tutors' preparatory workload by providing a ready-to-use structure that required minimal external guidance. Consequently, tutors were able to dedicate more time to active mentoring and addressing the specific conceptual difficulties of their tutees during the sessions.

Overall, the results (M = 4.88 for face-to-face; M = 4.84 for online) show that CHEM-SPARK was perceived by tutors as highly effective in enhancing academic, interpersonal, and instructional competencies across both modalities. The consistently high evaluations affirm that the workbook provided structured guidance, clear design, and opportunities for collaborative peer learning, consistent with studies underscoring the effectiveness of peer-assisted learning in developing tutor competence (Raymond et al., 2023). The minimal difference between the two modality scores indicates that the material is exceptionally versatile and maintains its pedagogical integrity even when transitioned to a digital format. These findings suggest that the CHEM-SPARK is a sustainable and dependable tool for long-term chemistry remediation programs in various educational settings.

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Table 5

Tutees' Perceptions in Face-to-Face and Online Peer Tutoring Sessions Using the CHEM-SPARK

Domain	Face-to-Face			Online		
	Domain SD	Grand Mean	Verbal Interpretation	Domain SD	Grand Mean	Verbal Interpretation
Emotional and Psychological Experience	0.51	4.61	Low Variability, Positive	0.53	4.63	Low Variability, Positive
Academic and Cognitive Benefits	0.62	4.54	Low Variability, Positive	0.55	4.64	Low Variability, Positive
Overall Perception and Future Involvement	0.53	4.59	Low Variability, Positive	0.53	4.62	Low Variability, Positive
Tutor Support and Interaction	0.54	4.57	Low Variability, Positive	0.48	4.63	Very Low Variability, Positive
Workbook Design and Effectiveness	0.55	4.54	Low Variability, Positive	0.45	4.74	Very Low Variability, Positive
Overall	**0.55**	**4.57**	**Low Variability, Positive**	**0.50**	**4.68**	**Very Low Variability, Positive**

Note: SD-Standard Deviation

Table 5 shows that tutees reported highly positive perceptions of their participation in peer tutoring sessions using the CHEM-SPARK workbook. The overall mean ratings were 4.57 (SD = 0.55) for face-to-face sessions and 4.68 (SD = 0.50) for online sessions. The results suggest that the workbook, together with the peer tutoring strategy, effectively supported the learners across emotional, cognitive, and instructional dimensions.

The positive perceptions in the emotional and psychological domains (M = 4.61, SD = 0.51 face-to-face; M = 4.63, SD = 0.53 online) suggest that CHEM-SPARK provided a supportive learning environment that fostered confidence and reduced anxiety. This aligns with Johnson & Johnson's (2018) Social Interdependence Theory, which emphasizes that positive interdependence fosters promotive interaction in which peers support one another's success. The structured tutor–tutee activities embedded in CHEM-SPARK, including guided discussions and step-by-step problem-solving exercises, appear to have contributed to the development of promotive interaction among participants. Recent studies have also demonstrated that peer tutoring enhances motivation and reduces negative emotions by fostering a collaborative climate (Darling-Hammond, & Cook-Harvey, 2018).

For the academic and cognitive benefits domain (M = 4.54, SD = 0.62 face-to-face; M = 4.64, SD = 0.55 online), results indicate that tutees acknowledged gains in understanding chemistry concepts with the aid of CHEM-SPARK. This is consistent with Vygotsky's (1978) Social Development Theory, particularly the Zone of Proximal Development, where learners progress with the support of more knowledgeable peers. The scaffolded activities embedded in CHEM-SPARK, such as step-by-step problem-solving and guided practice exercises,

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helped tutees achieve higher levels of understanding than they could independently. Contemporary findings confirm that peer tutoring fosters deeper comprehension when instructional materials are aligned with scaffolded learning strategies (Esparcia, Piñero, & Futalan, 2024).

For Overall Perception and Future Involvement, the mean scores remained high (M = 4.59, SD = 0.53 face-to-face; M = 4.62, SD = 0.53 online). This demonstrates tutees' willingness to engage in future peer tutoring activities using CHEM-SPARK, underscoring its sustainability as a remediation strategy. These results align with Tabrizi et al. (2017), who found that positive experiences in peer-assisted learning fostered students' willingness to join similar programs in the future. The alignment with Social Interdependence Theory (Johnson & Johnson, 2018) is also evident, as the success of both tutors and tutees is interlinked, encouraging continued participation.

The tutor support and interaction domain (M = 4.57, SD = 0.54 face-to-face; M = 4.63, SD = 0.48 online) received very positive feedback, highlighting the value of social interaction in the program. CHEM-SPARK supported this through structured tutor guides and prompts that encouraged communication. This reflects Reigeluth's (1999) Instructional Theory, which stresses the importance of instructional design in facilitating collaboration and peer support. The conduct of orientation and weekly monitoring enabled tutors to carry out their roles more effectively. Recent research also emphasizes that instructional resources that provide clear guidance to peer tutors significantly enhance the learning environment for both parties (Bacia, 2024).

Finally, Workbook Design and Effectiveness obtained one of the highest ratings (M = 4.54, SD = 0.55 face-to-face; M = 4.74, SD = 0.45 online), suggesting that CHEM-SPARK's features, such as the integration of illustrations, clear instructions, and well-structured activities with references, effectively supported diverse learners. According to Tomlinson's (2001) Principles of Materials Development, well-designed instructional materials should engage learners, accommodate multiple learning styles, and encourage self-investment. The positive feedback of the tutees shows that these principles were realized in CHEM-SPARK. Supporting this, Amos, Eghan, and Oppong (2022) found that instructional materials with authentic, engaging activities significantly improve student satisfaction and learning outcomes.

Overall, the grand mean of 4.57 in face-to-face sessions and 4.68 in online sessions indicates that CHEM-SPARK effectively enhanced tutees' learning experiences across both modalities. The high ratings show that the workbook fostered engagement and comprehension through its interactive design, which integrates peer collaboration, scaffolded instruction, and reflective learning. Aligned with the four guiding theories, these features highlight the CHEM-SPARK's pedagogical soundness, ensuring that learning remains active, meaningful, and contextually relevant for students.

Integrated Results of Peer Tutors' and Tutees' Experiences

The integration of quantitative and qualitative data on the experiences of peer tutors and tutees using the CHEM-SPARK revealed several strong and consistent themes. Overall, the results showed a high level of agreement between the two data sources, demonstrating the positive impact of the peer tutoring sessions and the effectiveness of CHEM-SPARK as a learning resource.

One of the major themes that emerged was the overall positive impact of the CHEM-SPARK and the peer tutoring program. Both peer tutors and tutees reported improved confidence, better understanding of chemistry concepts, and stronger interpersonal connections because of their participation. Quantitative data supported this finding, with very high mean scores across domains such as personal and interpersonal development, cognitive and academic development, and tutor support. These results are consistent with Vygotsky's Social Development Theory, which emphasizes that learning occurs through social interaction and guided support (Vygotsky, 1978).

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For peer tutors, the peer tutoring using the CHEM-SPARK experience promoted holistic development beyond academics. In the domain of personal and interpersonal development, face-to-face and online tutoring sessions both yielded mean scores above 4.75. These results align with qualitative statements from tutors who shared how the program helped them become more confident, patient, and effective in communicating with others. The program fostered leadership, improved teaching strategies, and encouraged collaboration among peers. These outcomes are consistent with the study by Cofer et al. (2022), which found that peer tutors reported significant gains in non-academic skillsets, including communication and interpersonal skills, as well as increased self-confidence and fulfillment.

In terms of academic development, peer tutors reported that teaching others deepened their understanding of chemistry topics. The cognitive and academic development domain showed consistently high ratings (M = 4.83 in both modes), and tutors described the experience as reinforcing their own learning. Many appreciated the opportunity to explain concepts clearly and help classmates grasp difficult topics. This dual role of learning while teaching was a meaningful part of their growth. These outcomes are consistent with the study by Putri et al. (2021), which demonstrated that peer tutoring significantly improved chemistry learning outcomes among high school students, highlighting the academic benefits of peer-assisted learning.

Support from teachers and the program's overall structure also contributed to the tutors' success. In the domain of mentorship and institutional support, both face-to-face and online participants gave perfect scores (M = 5.00, SD = 0.00). Tutors acknowledged the value of teacher guidance and the organized system that allowed them to thrive in their roles. They expressed gratitude for the encouragement and structure provided during the program. These outcomes are consistent with the study by van der Merwe et al. (2025), which demonstrated that mentoring and tutoring interventions can significantly enhance peer tutors' leadership skills, highlighting the importance of institutional support in fostering tutor development.

Regarding the CHEM-SPARK design and usefulness, peer tutors gave high ratings (Face-to-Face: M = 4.93; Online: M = 4.87) and described the workbook as easy to use, informative, and helpful. Some tutors suggested that while the workbook was generally effective, it was best used with guidance from a tutor or teacher to clarify certain parts. Despite these suggestions, the consensus was that the workbook served its purpose well.

For the peer tutees, the data showed similarly positive outcomes. In the domain of emotional and psychological experience, tutees reported that the workbook and tutoring sessions helped boost their confidence and reduce anxiety, particularly during recitations and exams. Mean scores of 4.61 and 4.63 for face-to-face and online sessions, respectively, support these observations. Tutees found the learning process more enjoyable and less stressful because of the support they received. These findings are consistent with those of Owusu-Fordjour et al. (2023), who demonstrated that peer tutoring significantly reduced anxiety among undergraduate students in integrated science courses, highlighting the emotional benefits of peer-assisted learning.

The academic and cognitive benefits of using the CHEM-SPARK were evident. Tutees described how the workbook helped them better understand chemistry topics, especially those they had struggled with in the past. The mean ratings in this domain were consistently strong, with 4.54 in face-to-face settings and 4.64 online. The workbook's structure and activities enabled tutees to build on their prior knowledge and address learning gaps with the help of their peers.

Regarding future involvement, many tutees expressed a desire to continue participating in peer tutoring programs. Their feedback reflected their appreciation for the program and its impact on their learning. This was evident in their ratings of overall perception and future involvement (Face-to-Face: M = 4.59; Online: M = 4.62), as well as in their positive comments expressing hope for more sessions.

Interaction with peer tutors was equally successful, as tutees valued the clear explanations and collaborative environment (M = 4.57 and M = 4.63), consistent with Shao, Kang, and Lu (2024), who found that supportive peer relationships significantly enhance academic achievement.

Lastly, the workbook's design and effectiveness were validated by the tutees. The workbook received favorable ratings (M = 4.54 and M = 4.74), and tutees shared that the instructions were easy to follow. They believed that it helped them learn independently and apply new knowledge even without direct teacher guidance.

In summary, the integration of data from peer tutors and tutees reveals a strong alignment in their experiences and perceptions. The CHEM-SPARK, together with the peer tutoring program, enhanced academic understanding, personal growth, and classroom engagement. These results affirm that the CHEM-SPARK is an effective resource for supporting chemistry learners through peer-assisted strategies. This finding is consistent with Aftab et al. (2023), who reported that peer tutoring improves academic performance and engagement among chemistry students. Likewise, Rahmasari et al. (2024) found that integrating structured materials, such as KWL charts, into peer tutoring fosters better comprehension and positive learning attitudes, while Herpratiwi et al. (2023) emphasized that peer tutoring worksheets enhance self-efficacy and learning outcomes. Collectively, these studies underscore that the effectiveness of peer tutoring is enhanced when supported by well-designed instructional materials such as CHEM-SPARK

Conclusions and Recommendations

The development of the CHEM-SPARK (CHEMistry Students' Peer-Assisted Resource Knowledge-book) followed the Borg and Gall (1983) R&D model, condensed into five stages: preparation, validation, revision, pilot testing, and finalization.

Expert evaluation by six teacher-experts yielded a grand mean of 4.93 (Excellent), with "Content" receiving a perfect score (5.00). Furthermore, the School Quality Assurance Team (SQAT) gave the material a "Passed" rating across all criteria, confirming its alignment with DepEd standards for accuracy and organization.

During the implementation phase, both tutors and tutees in face-to-face and online setups reported "Positive" experiences (means ranging from 4.57 to 4.88). Qualitative feedback highlighted that the workbook simplified complex concepts, fostered peer collaboration, and increased student confidence in Chemistry.

The results of this study suggest that the systematic development of CHEM-SPARK resulted in a high-quality, validated instructional tool suitable for classroom remediation. The utilization of a structured R&D process ensured the material was both scientifically rigorous and user-friendly. The positive reception from both experts and students underscores the potential effectiveness of peer-assisted learning when supported by well-structured resources. Ultimately, CHEM-SPARK may serve as a bridge for Grade 8 learners to overcome conceptual difficulties in Chemistry while enhancing their social and academic competence.

Based on the study's findings, several pathways for pedagogical practice and future academic inquiry are suggested. Grade 8 Science teachers are encouraged to adopt CHEM-SPARK as a primary remediation tool to support peer tutoring sessions and enhance student performance. To support this integration, school heads should facilitate professional development workshops focused on instructional material development and peer-tutoring strategies, which empowers educators to address localized learning gaps effectively. Regarding the evolution of the material itself, future iterations of Chemistry workbooks should incorporate more gamified activities and visual layouts alongside prompts that connect scientific concepts to Filipino culture and values. Furthermore, authors and developers should place greater emphasis on precise terminology for molecular

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attraction strengths and add metacognitive reflection sections to deepen conceptual retention. Finally, future research should expand upon these findings by employing quasi-experimental designs with larger sample sizes across multiple schools to statistically validate the impact of CHEM-SPARK on standardized test scores.

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