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DEVELOPMENT AND VALIDATION OF GASAPP BUDDY- A MOBILE APPLICATION FOR ANDROID USERS: A SUPPLEMENTARY MATERIAL IN GENERAL CHEMISTRY 1

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ABSTRACT

This developmental study aimed to design and develop GasApp Buddy, a mobile application serving as a supplementary instructional tool for teaching Gas Laws in General Chemistry 1 to Grade 12 learners at Iloilo National High School. The application integrates lessons, simulations, problem-solving activities, and assessments aligned with the Department of Education curriculum. Following a developmental research design, the application was evaluated using a structured checklist. Descriptive statistics and One-Way ANOVA were employed to analyze the results. Findings revealed that GasApp Buddy received "very high" evaluation ratings across all criteria, with no significant differences observed among validator groups. This indicates strong acceptance of the application as a supplementary instructional tool. The study recommends its implementation to support chemistry instruction and suggests further research into mobile learning applications within science education.

Keywords: *GasApp Buddy, Gas Laws, General Chemistry, instructional application*

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INTRODUCTION

Teaching the behavior of gases in introductory chemistry courses remains a persistent global challenge due to the abstract and mathematical nature of pressure–volume–temperature relationships and the difficulty learners face in visualizing molecular motion (Leite, 2020; Rivera & Sanchez, 2020). Although web-based simulations, such as PhET, offer interactive experiences, they often demand stable internet access and desktop platforms, which limits their reach in many educational settings (Rivera & Sanchez, 2020). While the proliferation of mobile devices has opened new avenues for self-paced, context-rich learning, there remains scant evidence of mobile applications specifically engineered for Gas Laws instruction at the secondary school level.

Under the K–12 curriculum, Senior High School (SHS) learners in the Philippines are required to master the Gas Laws in General Chemistry 1. However, many public schools report challenges such as outdated laboratories, insufficient teaching aids, and inconsistent internet connectivity (Department of Education [DepEd] Region VI, 2023). Paper-based and downloadable modules provided by DepEd often fail to engage digitally native learners or function reliably offline. Consequently, learner performance in gas-related topics on national assessments remains below desired proficiency benchmarks.

Within Western Visayas, disparities in Information and Communications Technology (ICT) infrastructure and teacher training have led to the uneven adoption of digital tools in chemistry classrooms (DepEd Region VI, 2023). While urban schools may integrate projector-based simulations, many rural schools continue to rely on static worksheets and "chalk-and-

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talk" methods. This technological divide contributes to inconsistent learner outcomes in chemistry across the region. In Iloilo Province specifically, many public secondary schools face high learner-to-equipment ratios, limited laboratory reagents, and a lack of dedicated digital supplements for chemistry instruction (DepEd Region VI, 2023). At Iloilo National High School (INHS), internal assessments for General Chemistry 1 reveal that over 60% of Grade 12 learners score below proficiency in topics related to Gas Laws (Iloilo National High School, 2024). Furthermore, focus-group interviews with INHS learners indicate that the interplay of pressure, volume, and temperature feels too abstract without interactive, real-time models, while teachers cite significant time constraints for conducting hands-on demonstrations.

Existing efforts to contextualize Gas Laws instruction—such as improvised materials for lecture settings (Rivera & Sanchez, 2020) and e-SIM modules for online learning (Navarette et al., 2023)—have demonstrated efficacy in boosting conceptual understanding. Additionally, Android-based inquiry materials have shown promise for Grade 10 physics learners (Villaruz et al., 2025). However, no mobile application has been developed specifically for the Philippine SHS Gas Laws curriculum that operates reliably offline, aligns precisely with the DepEd SHS General Chemistry 1 competencies, and integrates local language cues and curriculum-aligned assessments (Leite, 2020; Villaruz et al., 2025).

In response to these gaps, this developmental study proposed GasApp Buddy—a mobile application tailored to Senior High School General Chemistry 1 Gas Laws. GasApp Buddy functions offline, supports the local context, and embeds formative assessments aligned with INHS instructional standards. This research aimed to design and evaluate GasApp

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Buddy as a supplementary instructional material to enhance the teaching and learning of General Chemistry 1.

MATERIALS AND METHODS

Research Method

This study employed developmental research, specifically using a Design and Development model as described by Creswell and Creswell (2021), which emphasizes the systematic and iterative creation of educational products grounded in empirical inquiry. Guided by this approach, the study focused on the design, development, and evaluation of GasApp, a mobile application intended to supplement instruction on Gas Laws in General Chemistry 1.

The research would follow a structured sequence that includes:

(1) Iterative design, where prototypes of GasApp are developed based on instructional needs and theoretical foundations;

(2) Expert validation, in which Chemistry educators, Master Teachers, and application developers assess the app's content accuracy, usability, and instructional alignment; and

Consistent with Creswell's perspective on developmental research, the evaluation phase would involve both quantitative to determine GasApp's pedagogical effectiveness, technical reliability, content quality, and overall instructional value. Findings from each phase would inform inform iterative refinements, ensuring that the final version of GasApp is empirically validated, contextually relevant, and aligned with curriculum standards.

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Research Design

A developmental research design was adopted in the study, integrating quantitative approaches to systematically design, refine, and evaluate GasApp. Following the developmental research tradition, this study generated an instructional product through iterative cycles of design, development, and empirical validation, consistent with the recommendations of Creswell and Creswell (2021) for multi-phase research aimed at producing and evaluating educational innovations.

The quantitative component served as the primary basis for evaluating GasApp's instructional effectiveness. This included the administration on the use of evaluation checklist on the ease of use, engagement, content quality, technical reliability, and instructional value to gather numerical data from chemistry teachers, master teachers, and application developers.

Descriptive and inferential statistical analyses were employed to determine effectiveness, significance of improvements, and differences in app evaluations across stakeholder groups. These quantitative measures ensured an objective assessment of GasApp's pedagogical value and technical performance.

The study was guided by the ADDIE model—Analysis, Design, Development, and Evaluation of GasApp, which provides a structured, evidence-based framework for instructional product development.

During the Analysis phase, instructional challenges and learner needs related to Gas Laws were identified. The Design and Development phases involved creating prototypes of

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GasApp and integrating multimedia simulations, assessments, and offline modules aligned with curriculum standards.

Finally, the Evaluation phase combined formative evaluation (expert validation) and summative evaluation (effectiveness testing, stakeholder appraisal), ensuring that GasApp was rigorously examined and iteratively improved.

Through this developmental approach, the study ensured that GasApp Buddy was not only systematically created and refined, but also empirically validated in terms of its instructional impact, usability, and alignment with learners' needs and curriculum expectations.

Participants of the Study

The participants of the study were a panel of fifteen (15) validators, consisted of five (5) application developers, five (5) master teachers, and five (5) chemistry teachers who were involved in the expert validation and evaluation phases of the study.

The evaluation of GasApp was conducted by a diverse panel of fifteen experts, whose collective pedagogical, content-related, and technical insights ensured the application's accuracy, usability, and instructional alignment. The profiles of the validators are as follows:

Validator 1 is a System Test Engineer at Airnav Technology Services Incorporated and serves as the panel's IT expert. He graduated Cum Laude with a Bachelor of Science in Computer Science, majoring in Artificial Intelligence, from West Visayas State University.

Validator 2 is an Associate Professor V at the Iloilo State University of Fisheries Science and Technology (ISUFST) in Barotac Nuevo, Iloilo. A 33-year-old male with 12 years of

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teaching experience, he earned his PhD in Science Education from West Visayas State University. He is a recognized Technical Provider in Robotics Education and has published several research papers in Scopus-indexed journals.

Validator 3 is a Master Teacher II with 13 years of experience in education. He holds a PhD in Technology Management and currently serves as the Program Coordinator of the Strengthened Technical and Vocational Education Program (STVEP) at Iloilo National High School.

Validator 4, a 38-year-old Master Teacher I, has 9 years of teaching experience. He specializes in Animation within the TVL/ICT track at Iloilo National High School.

Validator 5 has six years of experience in academia, teaching ICT and specialized subjects. He completed the academic requirements (CAR) for a Master of Engineering at the Western Institute of Technology.

Validator 6 is a 63-year-old retired Master Teacher II and a licensed Chemical Engineer with 24 years of teaching experience and 11 years of industry experience in chemical analysis. She was a key proponent of the BS in Sugar Technology program at Negros State College of Agriculture (now Central Philippines State University) in Kabankalan City.

Validator 7 is a 33-year-old Master Teacher I at Iloilo National High School with 12 years of experience teaching Research and Science. An award-winning expert in Robotics and Intelligent Machines, she earned her PhD in Science Education (Mathematics) from West Visayas State University.

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Validator 8 is a 46-year-old Master Teacher at Iloilo National High School with 17 years of experience. She holds a Master of Arts in Education (Biology) from West Visayas State University and is currently pursuing a PhD in Science Education at the same institution. She is also a distinguished research adviser with success in national competitions.

Validator 9 is a 55-year-old Master Teacher II at Iloilo National High School with 33 years of experience. She has handled Earth and Life Science, Physical Science, and Chemistry. She earned her PhD in Science Education (Physical Science) from West Visayas State University.

Validator 10 is a 58-year-old Master Teacher II at Iloilo National High School, teaching Mathematics, Statistics, and Research in the Senior High School department. He obtained his PhD in Science Education (Mathematics) from West Visayas State University as a DOST scholar.

Validator 11 has 10 years of experience teaching Chemistry. A 37-year-old educator, she is an active YES-O adviser and a module author/contributor. She earned her Bachelor of Secondary Education (Physical Science) from West Visayas State University.

Validator 12 is a 34-year-old Teacher III at Miag-ao National High School with 13 years of service. He teaches Physics, Physical Science, and Capstone projects. He is currently a DOST scholar pursuing a PhD in Science (Mathematics) at West Visayas State University.

Validator 13 is a 32-year-old Teacher III at Iloilo National High School. She has taught Chemistry and Research for 10 years and holds a Master of Arts in Chemistry from West Visayas State University.

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Validator 14 is a 51-year-old educator with 26 years of teaching experience. She currently handles Chemistry subjects at Iloilo National High School.

Validator 15 is a 29-year-old teacher at Iloilo National High School with six years of experience, specifically handling Integrated Science and Chemistry.

These validators provided the critical expertise necessary to ensure the reliability and effectiveness of GasApp as a specialized instructional tool.

Research Instruments

This study has employed a primary research instrument to generate the quantitative data needed for evaluating GasApp: a GasApp Buddy Evaluation Checklist. These instruments are designed to measure learners' conceptual understanding of Gas Laws and experts' evaluation of the app in terms of usability, engagement, content quality, technical reliability, and instructional value.

The GasApp Usability Evaluation Checklist was a researcher-developed Likert-scale instrument used to evaluate the application from the perspectives of 15 expert validators, composed of chemistry teachers, master teachers in science, and application developers. The checklist consists of five dimensions, namely: ease of use, engagement, content quality, technical reliability, and instructional value, with 10 items per dimension, for a total of 50 items. Responses are rated on a 5-point scale ranging from Strongly Disagree to Strongly Agree.

The checklist was grounded in established principles of mobile learning usability, instructional design, multimedia learning, and curriculum alignment. Prior to administration,

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the instrument underwent expert validation, and its content validity was established through the Content Validity Index (CVI), while its internal consistency will be determined using Cronbach's alpha reliability analysis.

The validation panel further included five master teachers with extensive expertise in the English language, Science, and Information Technology. Their profiles are as follows:

Validator 1 is a 50-year-old Master Teacher II at Iloilo National High School, where she currently serves as the Learning Area Coordinator for Science in the Senior High School department. A distinguished educator, she is a former DOST scholar and a recipient of both the Monbusho and Australia Awards Scholarships. Her professional background is further enriched by her participation in various regional, national, and international trainings and workshops.

Validator 2 is a 52-year-old English language expert with 30 years of experience in academia. She is currently a Master Teacher II at Iloilo National High School and serves as the Learning Area Coordinator for Languages in the Senior High School department.

Validator 3 is a 44-year-old Master Teacher I with 21 years of experience teaching Science at Iloilo National High School. She earned her Doctor of Philosophy in Educational Management from the University of Guimaras and currently serves as a YES-O Club adviser.

Validator 4 is a 40-year-old Master Teacher I and the Research Coordinator at Iloilo National High School. She teaches Science and Research in the Senior High School department and holds a Doctor of Philosophy in Biology from West Visayas State University. Notably, she

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was recognized as the National Winner for Best Research Oral Paper at the 11th National Research Conference in Science and Mathematics Education in 2025.

Validator 5 is a 44-year-old Master Teacher I at Iloilo National High School, specializing in Computer Programming, Empowerment Technologies (E-Tech), and Media and Information Literacy (MIL). She is currently the Learning Area Coordinator for TVL/ICT and holds a Master of Management majoring in Information Technology.

The resulting data from these evaluations were analyzed using descriptive statistics, specifically mean and standard deviation, alongside appropriate inferential tests to determine potential differences in evaluations across the various validator groups.

Validity of the Research Instrument

The content validity of the research instruments was established through a rigorous expert review process. A panel of Chemistry/Science educators, instructional designers, and mobile application developers evaluated the alignment and usability evaluation indicators with the DepEd General Chemistry 1 curriculum standards, learning competencies, and instructional objectives. Their assessment was focused on the clarity, relevance, representativeness, and appropriateness of each item in measuring the intended constructs.

All suggestions, corrections, and recommendations provided by the experts were systematically incorporated into the instruments to enhance their precision and instructional relevance. This process ensured that the instruments validly and accurately measure conceptual understanding, usability, engagement, content quality, technical reliability, and instructional value.

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Data Gathering Procedures

Data collection was conducted in three phases. These three phases are (1) Analyzing; (2) Designing; (3) Developing. The purpose of these phases was to produce an Android based supplementary materials in Chemistry 1.

I. Analyzing Phase

In this phase, mobile-based learning was used as a basis for developing supplementary material in Chemistry 1 specifically in Gas Laws. Reduced learners' motivation that resulted to low scores, learners' engagement, and the abstract mathematical nature of pressure-volume-temperature relationships serve as the basis of developing a curriculum based supplementary material in Gas Laws.

II. Designing Phase

This phase focused on designing a prototype supplementary material on Gas Laws. Contents were designed according to the competency for Gas Laws. Media lay-out and features like pictures and animations were conceptualized.

III. Developing

The purpose of this phase was to produce an Android application using software. This was done in collaboration with the software developer, Benjamin L. Cornelio Jr., PhD.

The development process focused on system requirements, design, coding/programming. Slides were programmed into a dynamic presentation that can be moved from one slide to the

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other. Transition and custom animation, and background music were added to enhanced the effects.

After the development of the App, the researcher's made instrument was used to validate the application by the experts, which consists of 5 Chemistry teachers, 5 Master teachers, and 5 IT experts/web developers. They have validated the application base on 5 criteria; (1) ease of use; (2) engagement; (3) content quality; (4) technical reliability; and (5) instructional value.

After validation, the GasApp was enhanced and improved according to the recommendations of the evaluators. Concurrently, usability checklists and interviews have been conducted to gather qualitative data on user experience and instructional value.

Data Analyses

The data collected in this study was analyzed using quantitative statistical techniques to determine the effectiveness of GasApp Buddy based on experts' evaluations. Descriptive statistics such as mean, median, frequency counts, percentage distributions, and standard deviation were computed to summarize both learner scores and usability ratings.

To evaluate the effectiveness of GasApp Buddy on student learning, evaluators assessed the reliability and validity of the GasApp Buddy, inferential analysis focused on differences among evaluator groups. Thus, inferential analysis was centered on the expert usability evaluations of GasApp.

For the evaluation checklist, which was rated by three distinct groups of validators—chemistry teachers, master teachers, and application developers—differences in their

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evaluations were tested using a one-way Analysis of Variance (ANOVA). This statistical test was used to determine whether the groups differ significantly in their assessments across the dimensions of usability, engagement, content quality, technical reliability, and instructional value. When the ANOVA yields a significant result, a post hoc test (such as Tukey's HSD) was conducted to identify which specific groups differ from one another. This approach was appropriate for multiple-group comparisons and ensures that the interpretation of group differences remains statistically rigorous.

Weighted mean scores were also be computed for each checklist indicator to determine the overall acceptability, performance, and instructional suitability of the application. These results were compared across groups to provide a comprehensive understanding of evaluator perspectives.

All statistical computations were performed using SPSS or Microsoft Excel to ensure accuracy and consistency. A 0.05 level of significance was used for all inferential analyses.

RESULTS AND DISCUSSION

The presentation, analysis, and interpretation provided serve as the basis for determining the acceptability and instructional suitability of GasApp Buddy as a supplementary learning tool for Senior High School learners studying Gas Laws in General Chemistry 1.

Specifically, this study sought to answer the following questions,

1. What supplementary materials in Chemistry 1 can be developed specifically for Gas Laws?

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2. What was the level of ease of use of GasApp as evaluated by chemistry teachers, master teachers, and application developers?

3. What was the level of engagement of GasApp as evaluated by chemistry teachers, master teachers, and application developers?

4. What was the level of content quality of GasApp as evaluated by chemistry teachers, master teachers, and application developers?

5. What was the level of technical reliability of GasApp as evaluated by chemistry teachers, master teachers, and application developers?

6. What was the level of instructional value of GasApp as evaluated by chemistry teachers, master teachers, and application developers?

7. What was the overall evaluation of GasApp Buddy?

8. Were there significant differences in the ease of use, engagement, content quality, technical reliability, and instructional value according to the evaluator group?

Developed Supplementary Material for Gas Laws

The development of mobile-based educational applications requires appropriate software frameworks that support interactive multimedia learning, efficient performance, and cross-platform compatibility. Modern educational applications increasingly utilized integrated development environments that allow the incorporation of animations, simulations, and user-

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controlled interactions to support conceptual learning in science (Gomez & Santos, 2024; Lee, 2023).

Game-engine–based platforms such as Unity have been widely adopted in educational technology development because they support real-time rendering, multimedia integration, and interactive simulations essential for visualizing abstract scientific concepts (Johnson et al., 2022). Unity 2D provides an efficient environment for developing interactive learning applications because it allows developers to integrate graphics, sound, and user interactions into a cohesive instructional platform while maintaining compatibility with Android-based devices (Torres et al., 2023).

Programming languages also played a critical role in the functionality and usability of educational applications. Object-oriented programming languages such as C# enable structured implementation of user interface controls, system logic, and event-driven interactions required in mobile learning environments (Lee, 2023). C# is particularly suitable for Unity-based development because it supports modular coding structures, efficient memory management, and responsive application behavior, which are necessary for offline educational applications operating on mobile devices (Chen & Santos, 2022).

Educational applications that integrate multimedia elements such as animations, simulations, sound effects, and interactive assessments have been shown to improve learner engagement and conceptual understanding in science subjects (Lopez & Garcia, 2023; Reyes & Lopez, 2021). The transformation of static instructional modules into dynamic multimedia environments aligns with contemporary mobile learning approaches that emphasize

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visualization, learner interaction, and self-paced exploration (Smith & Nguyen, 2021). Offline-capable applications further enhance accessibility by allowing learners to engage with instructional content without dependence on internet connectivity, making them particularly suitable for resource-constrained educational settings (Gomez & Santos, 2024).

Guided by these principles, the supplementary material developed in this study, GasApp Buddy, was designed using Unity 2D as the development platform and C# as the programming language. The application converted the static contents of the General Chemistry 1 Self-Learning Module into interactive multimedia lessons incorporating simulations, images, background music, and guided problem-solving activities. The use of Unity 2D enabled efficient integration of multimedia assets and interactive simulations, while C# programming supported system functionality, navigation controls, and user interactions within the application environment.

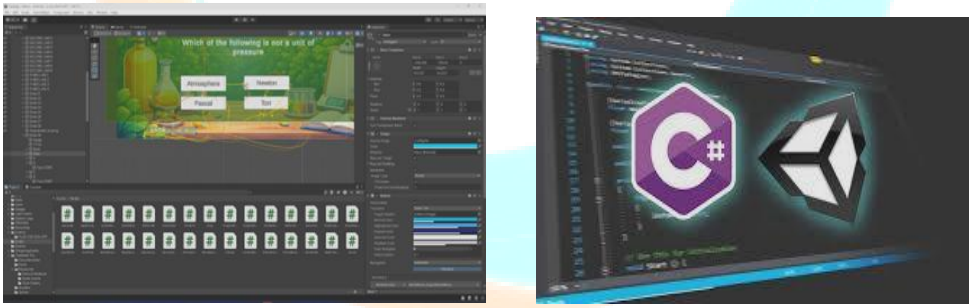

Fig. 2 Unity 2D as the development platform and C# as the programming language

Several software tools were utilized during the development of the system to support visual design, asset creation, and multimedia integration. Graphic editing software such as Adobe Photoshop was used to create and refine two-dimensional graphics, icons, sprites, and

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user interface components. Online design platforms such as Canva were also employed to produce instructional visuals and layout elements efficiently. The use of digital graphic tools in educational application development enhances visual clarity and supports effective multimedia learning by improving the presentation of instructional materials (Lee, 2023; Lopez & Garcia, 2023).

Artificial intelligence–generated images were incorporated to provide contextual illustrations and visual representations of gas behavior and molecular motion. AI-assisted image generation allows developers to rapidly produce customized educational graphics that support conceptual visualization in science learning environments (Sun et al., 2025). In addition, royalty-free AI-generated background music was integrated into the application to create a positive and engaging learning atmosphere. The inclusion of appropriate audio elements in multimedia instructional materials has been shown to increase learner motivation and sustain engagement during self-paced learning activities (Reyes & Lopez, 2021).

These software tools supported the efficient development of GasApp Buddy by enabling the integration of multimedia elements such as graphics, animations, and audio into a cohesive and interactive mobile learning environment.

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Fig.3 Adobe Photoshop used for creating and editing 2D graphics, sprites, icons, and user interface elements.

Overview of the Developed Android Application- GasApp Buddy

About the App

GasApp Buddy is an Android-based mobile application designed as a supplementary instructional material for teaching Gas Laws in General Chemistry 1. The application was developed by the researcher, Ms. Gemma H. Jotea, in collaboration with the software developer Mr. Benjamin Cornelio Jr., PhD, and the research adviser Dr. Ma. Anavi C. Echavarri. The application was designed to function as an offline-capable mobile learning tool, allowing learners to access lessons even without internet connectivity. Offline accessibility is considered an essential feature of educational mobile applications, particularly in areas where stable internet connections are limited, because it ensures continuity of learning and equal access to instructional resources (Gomez & Santos, 2024; Chen & Santos, 2022). GasApp Buddy integrates multimedia elements including textual lessons, animated illustrations, background music, interactive simulations, and guided problem-solving activities to demonstrate the relationships among pressure, volume, temperature, and the number of moles of gases. The integration of multimedia elements enhances conceptual understanding because learners are able to visualize abstract scientific concepts through dynamic representations rather than static text alone (Lopez & Garcia, 2023; Smith & Nguyen, 2021).

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When the application icon is pressed, a welcome screen appears and learners must select the "Explore" button in order to proceed to the next interface. The next screen requires learners to enter their name, course, year level, and section, as shown in Figure 3. The inclusion of learner information allows the application to organize user records and track learning progress. Educational applications that incorporate structured learner input support better monitoring of learner performance and engagement (Johnson et al., 2022). After entering the required information, learners proceed to a 15-item multiple-choice pre-assessment, which is shown in Figure 4. The test items were adapted from the Self-Learning Module developed by Science experts from the Schools Division of Iloilo and from the textbook *Exploring Life Through Science* (Bayquen et.al, 2016). The purpose of the pre-assessment is to determine the learners' prior knowledge of Gas Laws before engaging with the instructional modules. Diagnostic assessments are important components of instructional applications because they activate prior knowledge and help identify misconceptions that may interfere with learning (Reyes & Lopez, 2021).

Immediate feedback is provided after each response during the pre-assessment. When a learner selects an answer, the application displays "Correct" if the response is accurate and "Incorrect" if the response is incorrect, as illustrated in Figure 5. Learners are required to complete all 15 items before proceeding to the next section. After completing the pre-assessment, the learner's total score is automatically displayed on the screen, as shown in Figure 6. Immediate feedback mechanisms are essential in mobile learning environments because they support self-regulated learning and allow learners to correct misunderstandings

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in real time (Lopez & Garcia, 2023). Research indicates that instant feedback improves conceptual understanding and increases learner confidence when studying complex scientific concepts (Johnson et al., 2022).

The main menu of GasApp Buddy contains six instructional topics: Behavior of Gases, Variables in Gas Laws, Boyle's Law, Charles's Law, Avogadro's Law, and the Ideal Gas Equation. These topics were selected based on the competencies outlined in the DepEd General Chemistry 1 curriculum guide to ensure alignment with classroom instruction. Curriculum-aligned mobile applications improve instructional consistency and strengthen the integration of digital learning tools into formal teaching practices (Ramlan & Nasir, 2023). Each topic can be accessed through navigation buttons located on the Main Menu. The interface includes navigation controls labeled "Next," "Back," and "Main," which allow learners to move efficiently between lessons. User-friendly navigation is an important design principle because intuitive controls reduce cognitive load and enable learners to concentrate on understanding the instructional content (Lee, 2023).

Selecting the Behavior of Gases button displays the characteristics and properties of gases, as presented in Figure 7. Learners may move between slides using the navigation buttons to review concepts as needed. Selecting the Variables in Gas Laws button displays the fundamental variables involved in gas behavior, including pressure, temperature, and volume, together with the corresponding unit conversion factors, as illustrated in Figure 8. Presenting prerequisite knowledge prior to advanced topics supports scaffolded learning and strengthens

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conceptual understanding by building knowledge progressively from simple concepts to more complex relationships (Reyes & Lopez, 2021; Smith & Nguyen, 2021).

Selecting the Boyle's Law button displays the pressure–volume relationship and the corresponding mathematical formula, as shown in Figure 9. When the "Next" button is pressed, learners are directed to an interactive simulation illustrating the relationship between pressure and volume, as presented in Figure 10. The simulation allows learners to manipulate a slider control in order to observe how changes in pressure affect volume. Interactive simulations are highly effective instructional tools in chemistry because they allow learners to visualize molecular processes that cannot be directly observed in traditional classroom instruction (Kumar et al., 2022). Studies have shown that simulation-based learning environments improve learners' understanding of Gas Laws by linking mathematical equations with graphical and visual representations (Lopez & Wu, 2024).

After completing the simulation activities, learners are presented with a Boyle's Law sample problem, as shown in Figure 11. The following screen displays a step-by-step solution, which guides learners through the correct procedure for solving Gas Law problems. Guided problem-solving activities enhance learners' analytical thinking and improve their ability to apply mathematical relationships in chemistry (Johnson et al., 2022). Learners are then required to answer guided questions by selecting the correct response. A smiley emoji appears for correct answers, while a sad emoji appears for incorrect responses. The next section titled "It's Time for a Drill! Boyle's Law" provides additional practice problems for independent learning, as illustrated in Figure 12, while the feedback for learner responses is shown in

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Figure 13. Practice exercises with immediate feedback strengthen conceptual understanding and improve long-term retention of scientific concepts (Reyes & Lopez, 2021).

By pressing the "Next" button, learners proceed to the Charles's Law module, as shown in Figure 14. Alternatively, learners may return to the Main Menu and select any topic directly. The same instructional sequence is followed for Charles's Law, Avogadro's Law, and the Ideal Gas Equation, ensuring consistency in lesson presentation and navigation. Consistent instructional structures improve usability and allow learners to focus on content rather than adjusting to different interface patterns (Lee, 2023).

The final section of the application consists of a 15-item multiple-choice post-assessment, which measures learners' understanding after completing the instructional modules. The post-assessment is designed to evaluate learners' conceptual understanding of Gas Laws after using GasApp Buddy as a supplementary learning tool. Embedding assessment activities within mobile learning environments improves both learner achievement and engagement by reinforcing key concepts through repeated practice (Johnson et al., 2022; Lopez & Garcia, 2023).

Each slide in the application is enhanced with animated illustrations and relaxing background music in order to create a positive and motivating learning environment. The inclusion of multimedia elements such as animation and audio has been shown to increase learner engagement and sustain attention during self-paced learning activities (Reyes & Lopez, 2021). Through the integration of structured lessons, interactive simulations, guided problem-

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solving activities, and multimedia elements, GasApp Buddy provides a comprehensive and engaging supplementary learning environment for Gas Laws in General Chemistry 1.

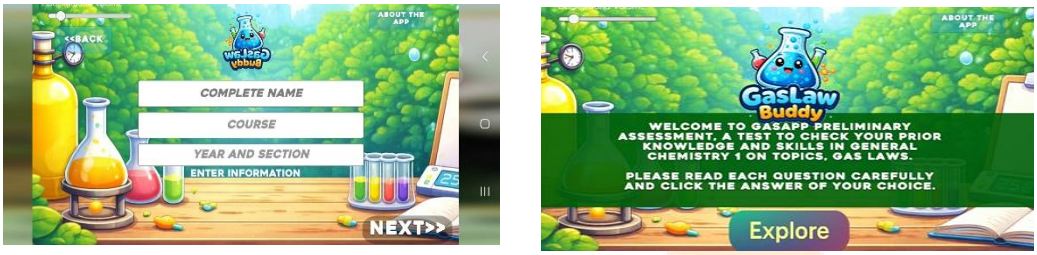
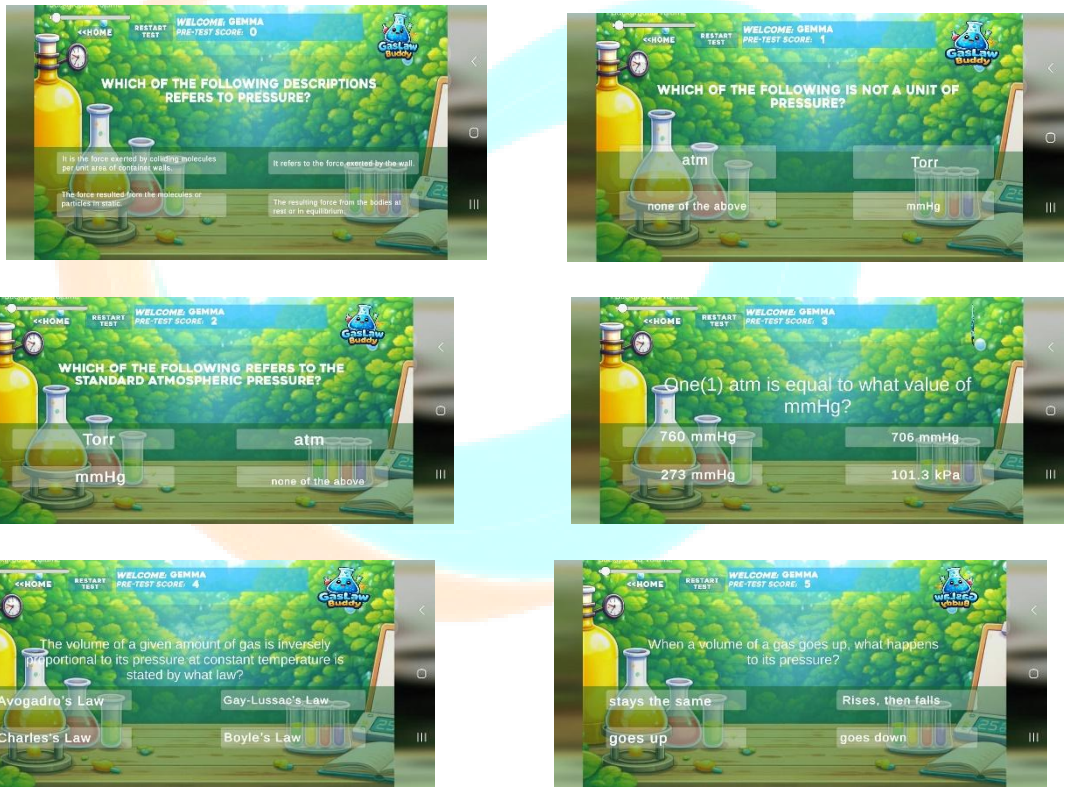


Figure 4. User Information Input Interface of GasApp Buddy Showing Fields for Name, Course, Year, and Section



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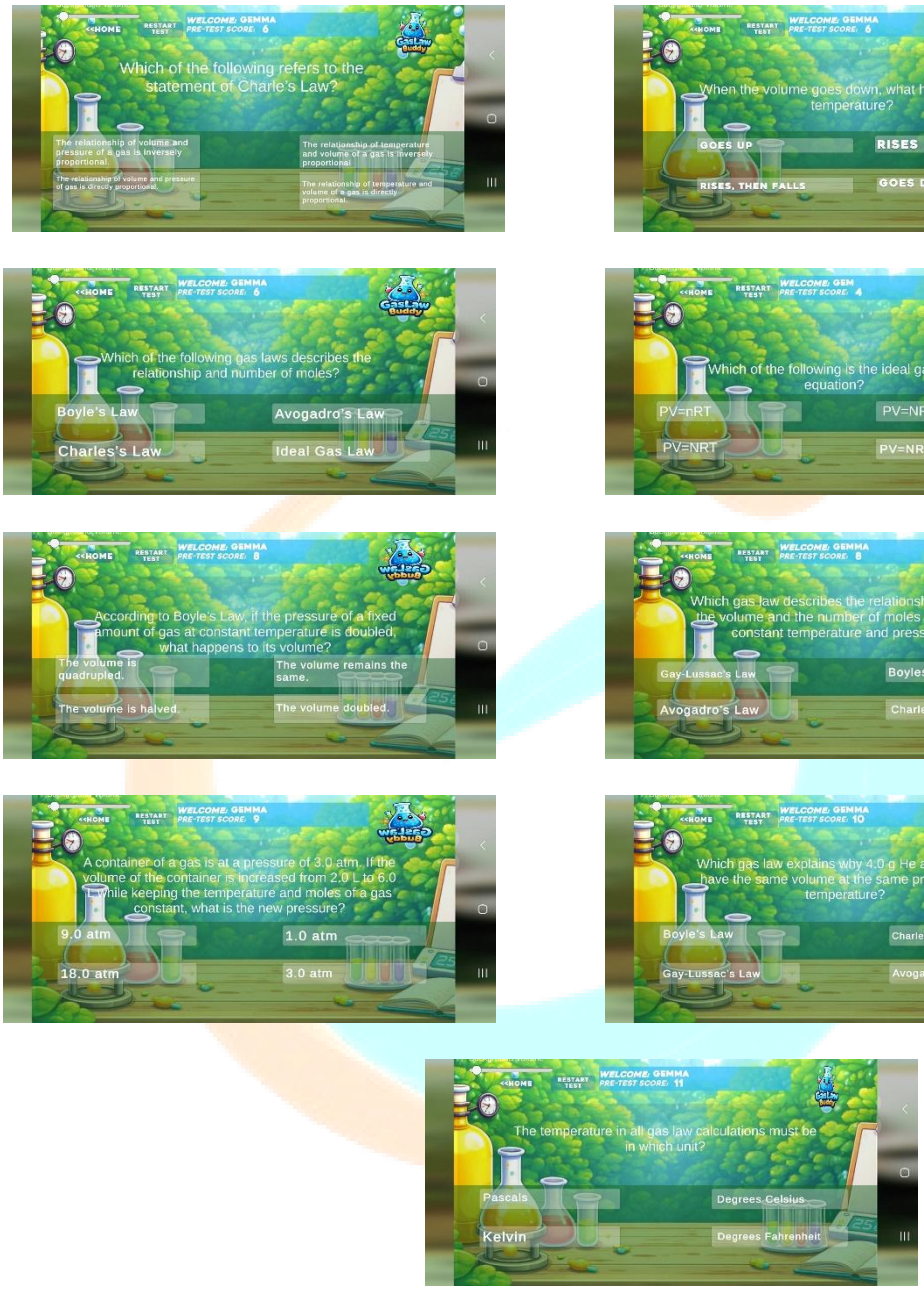

Figure 5. Pre-Assessment Interface Showing the 15-Item Multiple-Choice Test on Gas Laws

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Figure 6. Immediate Feedback Interface Showing Correct and Incorrect Responses During the Pre-Assessment

Figure 7. Pre-Assessment Result Screen Displaying the Learner's Total Score

Figure 8. Behavior of Gases Instructional Module Interface in GasApp Buddy

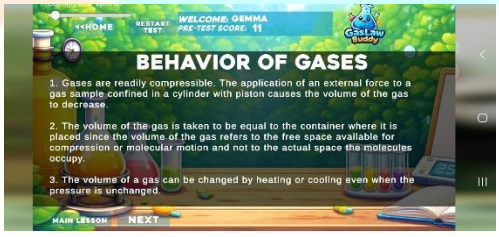

Figure 9. Variables in Gas Laws Module Showing Pressure, Temperature, Volume, and Conversion Factors

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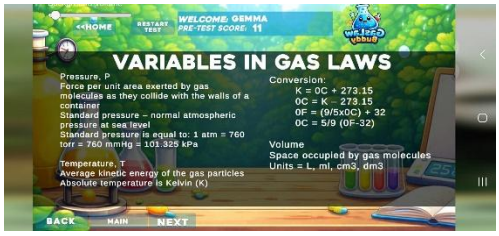

Figure 10. Boyle's Law Instructional Screen Showing the Pressure–Volume Relationship and Formula

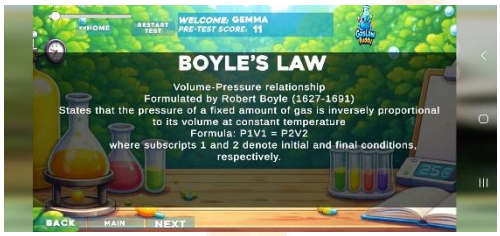

Figure 11. Interactive Boyle's Law Simulation Showing the Relationship Between Pressure and Volume

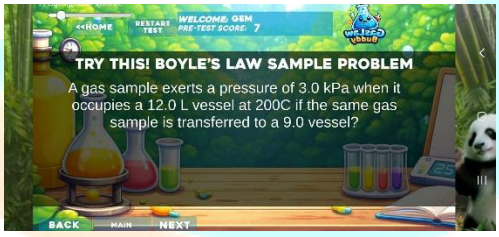

Figure 12. Boyle's Law Sample Problem Interface with Guided Solution Steps

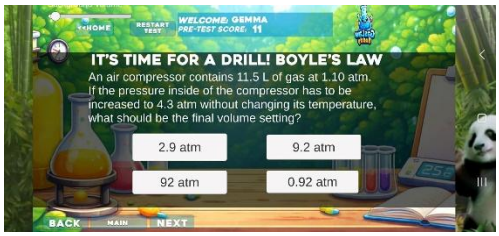

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Figure 13. Boyle's Law Practice Exercise Interface for Independent Problem Solving

Figure 14. Immediate Feedback Interface Showing Correct and Incorrect Answers in Practice Exercises

Figure 15. Charles's Law Instructional Module Interface in GasApp Buddy

Figure 16. Pre and Post Assessment Test Result Screen Displaying the Learner's Score

Experts Validation on the Developed GasApp

Level of Ease of Use of GasApp Buddy as Evaluated by the Validators

Table 1 presents the level of ease of use for GasApp Buddy as evaluated by 15 validators, including chemistry teachers, master teachers, and application developers. The

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results reveal that GasApp Buddy obtained an area mean of M = 4.55 (SD = 0.55), which is interpreted as Very High. This indicates that the application is highly usable, well-structured, and appropriate for Senior High School learners. These findings suggest that GasApp Buddy provides a user-friendly learning environment that allows learners to navigate instructional modules efficiently and independently.

The highest-rated indicators were Indicator 3 ("Users can independently access lessons and assessments without the need for technical assistance") and Indicator 5 ("The overall design of the application is appropriate for Senior High School learners"). Both indicators obtained a mean score of M = 4.60 (SD = 0.51), interpreted as Very High. These results indicate that GasApp Buddy enables learners to use the application independently and that its design is suitable for the intended users. The high rating for independent accessibility suggests that learners can operate the application without relying on technical support, which is particularly important in educational environments with limited technological assistance. This supports the goal of mobile learning to promote learner autonomy and self-paced learning (Ramlan & Nasir, 2023). Furthermore, the high rating for design appropriateness indicates that the interface, content presentation, and navigation structure align with the cognitive and developmental characteristics of Senior High School learners. Age-appropriate instructional design has been shown to improve comprehension and engagement in mobile learning environments (Lopez & Garcia, 2023).

The next set of indicators obtained mean scores of M = 4.53 (SD = 0.52), also interpreted as Very High; these include Indicators 1, 2, 7, 8, and 9. Indicator 1 ("The

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application interface is intuitive and allows learners to navigate its features easily") demonstrates that the overall interface design allows learners to move across modules without confusion. An intuitive interface is critical because it reduces cognitive load, allowing learners to concentrate on understanding instructional content rather than learning how to operate the application (Lee, 2023). Indicator 2 ("The instructional prompts and icons are clear, consistent, and easily understood by learners") suggests that the visual cues and instructions effectively guide learners through lessons and activities. Clear prompts and consistent icons support efficient navigation and improve the user experience in mobile learning (Torres et al., 2023).

Similarly, Indicator 7 ("The overall structure of the application is simple and well organized and does not overwhelm users") indicates that the application presents information in manageable sections. Organized instructional structures are vital as they support progressive learning and prevent cognitive overload (Reyes & Lopez, 2021). Indicator 8 ("First-time users can operate the application independently with minimal guidance") indicates that new users can quickly master the application. Tools that are easily operated by first-time users promote accessibility and encourage continuous use (Lee, 2023). Additionally, Indicator 9 ("The information presented on each screen is organized logically and systematically") indicates that content is arranged in a clear manner. Logical presentation helps learners connect concepts effectively and supports conceptual understanding in science (Smith & Nguyen, 2021).

The remaining indicators also obtained mean scores of M = 4.53 (SD = 0.64), interpreted as Very High, including Indicators 4, 6, and 10. Indicator 4 ("The application layout

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supports smooth and logical navigation across instructional modules") indicates that the arrangement of lessons follows a consistent sequence. Structured navigation supports scaffolded learning by allowing learners to move progressively from basic to advanced topics (Reyes & Lopez, 2021). Indicator 6 ("Buttons, menus, and tabs respond accurately and consistently to user actions") indicates that navigation controls function reliably. Reliable system responses are essential in educational applications, as technical inconsistencies may interrupt learning and reduce engagement (Gomez & Santos, 2024). Finally, Indicator 10 ("The application allows users to easily return to previously viewed content") indicates that learners can review lessons as needed. The ability to revisit content supports repeated learning and improves the retention of scientific concepts (Reyes & Lopez, 2021).

Overall, the results indicate that GasApp Buddy achieved a Very High level of ease of use (M = 4.55, SD = 0.55). This demonstrates that the application is user-friendly, accessible, and appropriate for Senior High School learners. The consistently high ratings across all indicators confirm that GasApp Buddy can function effectively as supplementary instructional material that supports independent and self-paced learning in General Chemistry 1.

Table 1

Level of Ease of Use of GasApp Buddy as Evaluated by the Validators

Item	Statement	SD	M	Interpretation
1	The application interface is intuitive and allows learners to navigate its features easily.	0.52	4.53	Very High
2	The instructional prompts and icons are clear, consistent, and easily understood by learners.	0.52	4.53	Very High

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Item	Statement	SD	M	Interpretation
3	Users can independently access lessons and assessments without the need for technical assistance.	0.51	4.60	Very High
4	The application layout supports smooth and logical navigation across instructional modules.	0.64	4.53	Very High
5	The overall design of the application is appropriate for Senior High School learners.	0.51	4.60	Very High
6	Buttons, menus, and tabs respond accurately and consistently to user actions.	0.64	4.53	Very High
7	The overall structure of the application is simple and well organized and does not overwhelm users.	0.52	4.53	Very High
8	First-time users can operate the application independently with minimal guidance.	0.52	4.53	Very High
9	The information presented on each screen is organized logically and systematically.	0.52	4.53	Very High
10	The application allows users to easily return to previously viewed content.	0.64	4.53	Very High

Likert Scale: 1.00–1.49 Very Low | 1.50–2.49 Low | 2.50–3.49 Moderate | 3.50–4.49 High | 4.50–5.00 Very High

Level of Engagement of GasApp Buddy as Evaluated by the Validators

Table 2 presents the level of engagement for GasApp Buddy as evaluated by 15 validators, including chemistry teachers, master teachers, and application developers. The results reveal that GasApp Buddy obtained an area mean of M = 4.64 (SD = 0.43), which is interpreted as Very High. This indicates that the application effectively promotes learner interest, motivation, and active participation. These findings suggest that GasApp Buddy

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provides an engaging learning environment that supports sustained interaction with Gas Laws concepts.

The highest-rated indicators were Indicator 8 ("The gamified features of the application increase learner motivation and engagement") and Indicator 9 ("The application promotes a sense of accomplishment after completing tasks or activities"). Both indicators obtained a mean score of M = 5.00 (SD = 0.00), interpreted as Very High. These results indicate unanimous agreement among validators that the gamified components of GasApp Buddy significantly enhance learner motivation. The integration of game-like elements—such as feedback responses, interactive drills, and progress-based activities—helps maintain interest while studying complex Gas Laws. This finding aligns with the principles of Self-Determination Theory, which emphasizes that feelings of competence and achievement increase intrinsic motivation (Patel & Chen, 2024). Similarly, Santos and Velasco (2024) reported that gamified mobile simulations increase learner participation and motivation in Gas Laws instruction.

The next group of indicators obtained mean scores interpreted as Very High (M = 4.53); this group includes Indicators 1, 4, 5, 6, and 10. Indicator 1 ("The application includes features that effectively sustain learner interest and motivation") obtained M = 4.53 (SD = 0.52), indicating that the integrated features successfully maintain attention throughout the instructional modules. Interactive multimedia features, such as simulations and guided activities, are known to sustain interest in science learning (Lopez & Garcia, 2023). Indicator 4 ("The application fosters learner autonomy through exploration and self-directed learning") obtained M = 4.53 (SD = 0.64), suggesting that learners can navigate the application

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independently. Mobile learning environments that support exploration enhance engagement by allowing students to control their own learning pace (Ramlan & Nasir, 2023).

Furthermore, Indicator 5 ("The overall design of the application is engaging and appropriate for the target age group") obtained M = 4.53 (SD = 0.52), indicating that the design matches the interests and learning preferences of Senior High School learners. Age-appropriate multimedia design has been shown to improve learning experiences in mobile applications (Reyes & Lopez, 2021). Indicator 6 ("The activities in the application encourage continuous learner participation throughout the modules") also obtained M = 4.53 (SD = 0.52), suggesting that the structured activities motivate learners to persist through lessons. Continuous participation is a vital characteristic of effective mobile learning, as it promotes sustained attention and deeper conceptual understanding (Smith & Nguyen, 2021). Additionally, Indicator 10 ("Learners are likely to revisit the application due to its engaging and motivating features") obtained M = 4.53 (SD = 0.52), highlighting the potential for repeated use beyond classroom instruction. Reyes and Lopez (2021) noted that applications promoting repeated engagement improve knowledge retention and conceptual mastery.

Two indicators obtained mean scores interpreted as High: Indicator 2 and Indicator 3, both with M = 4.47 (SD = 0.52). Indicator 2 ("The interactive elements such as simulations and quizzes promote active learning among learners") indicates that these elements effectively support interaction with content. Interactive environments help learners visualize abstract chemistry concepts and improve understanding (Kumar et al., 2022; Lopez & Wu, 2024). Similarly, Indicator 3 ("The feedback mechanisms in the application encourage learner

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persistence and self-correction") obtained M = 4.47 (SD = 0.52), suggesting that the feedback supports learner improvement. Immediate feedback allows learners to identify and correct misconceptions in real time, which enhances learning outcomes (Johnson et al., 2022).

The lowest-rated indicator was Indicator 7 ("The visual and audio elements of the application capture learner attention effectively"), which obtained M = 4.33 (SD = 0.49), interpreted as High. While this was the lowest mean score, it still reflects a positive evaluation. The result suggests that while the multimedia elements effectively support engagement, they may offer opportunities for further refinement. According to the Cognitive Theory of Multimedia Learning, the integration of visuals and audio enhances learning when properly aligned with instructional objectives (Reyes & Lopez, 2021). Overall, the results indicate that GasApp Buddy achieved a Very High level of engagement (M = 4.64, SD = 0.43).

Table 2

Level of Engagement of GasApp Buddy as Evaluated by the Validators

Item	Statement	SD	M	Interpretation
1	The application includes features that effectively sustain learner interest and motivation.	0.52	4.53	Very High
2	The interactive elements such as simulations and quizzes promote active learning among learners.	0.52	4.47	High
3	The feedback mechanisms in the application encourage learner persistence and self-correction.	0.52	4.47	High
4	The application fosters learner autonomy through exploration and self-directed learning.	0.64	4.53	Very High
5	The overall design of the application is engaging and appropriate for the target age group.	0.52	4.53	Very High

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Item	Statement	SD	M	Interpretation
6	The activities in the application encourage continuous learner participation throughout the modules.	0.52	4.53	Very High
7	The visual and audio elements of the application capture learner attention effectively.	0.49	4.33	High
8	The gamified features of the application increase learner motivation and engagement.	0.00	5.00	Very High
9	The application promotes a sense of accomplishment after completing tasks or activities.	0.00	5.00	Very High
10	Learners are likely to revisit the application due to its engaging and motivating features.	0.52	4.53	Very High

Likert Scale: 1.00–1.49 Very Low | 1.50–2.49 Low | 2.50–3.49 Moderate | 3.50–4.49 High | 4.50–5.00 Very High

Level of Content Quality of GasApp Buddy as Evaluated by the Validators

Table 3 presents the level of content quality for GasApp Buddy as evaluated by 15 validators, including chemistry teachers, master teachers, and application developers. The results reveal that GasApp Buddy obtained an area mean of M = 4.75 (SD = 0.37), interpreted as Very High. This indicates that the instructional content of the application is accurate, well-structured, curriculum-aligned, and appropriate for Senior High School learners. These findings suggest that GasApp Buddy provides high-quality instructional materials that effectively support the teaching and learning of Gas Laws in General Chemistry 1.

The highest-rated indicators were Indicator 3 ("The quiz questions included in the application are aligned with the concepts taught in class"), Indicator 4 ("The instructional content of the application is aligned with the prescribed chemistry curriculum"), and Indicator

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5 ("The application uses language that is clear and easy for learners to understand"). All three indicators obtained mean scores of M = 5.00 (SD = 0.00), interpreted as Very High. These results indicate unanimous agreement among validators that the instructional content of GasApp Buddy is strongly aligned with the DepEd General Chemistry 1 curriculum and that the language used is accessible to the target audience. Curriculum alignment is essential in educational applications because it ensures that digital learning materials complement classroom instruction and address required learning competencies (Ramlan & Nasir, 2023). Furthermore, the use of clear language supports effective learning by allowing students to interpret scientific concepts without confusion. Reyes and Lopez (2021) emphasized that well-structured instructional language improves comprehension and supports conceptual learning in mobile environments.

The next group of indicators obtained mean scores of M = 4.60 (SD = 0.51), interpreted as Very High; this group includes Indicators 6, 7, 8, 9, and 10. Indicator 6 ("The instructional content presented in the application is scientifically accurate") indicates that the lessons in GasApp Buddy are consistent with accepted scientific principles. Scientific accuracy is a fundamental requirement of instructional materials, as incorrect information may lead to misconceptions and learning difficulties (Lopez & Wu, 2024). Similarly, Indicator 7 ("The instructional approach used in the application is pedagogically appropriate for the learners") indicates that the teaching strategies used in GasApp Buddy match the learning needs and abilities of Senior High School students. Pedagogically appropriate approaches support meaningful learning and improve conceptual understanding (Reyes & Lopez, 2021).

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Indicator 8 ("The explanations and examples provided in the application are age-appropriate and contextually relevant") suggests that the examples used are suitable for the academic level of the learners. Contextually relevant materials improve engagement because students can relate scientific concepts to real-life situations (Lopez & Garcia, 2023). Indicator 9 ("The assessment items reflect the appropriate cognitive levels required in Gas Laws instruction") indicates that the quiz questions measure the various thinking skills required in General Chemistry 1. Well-designed assessment items support both conceptual understanding and problem-solving skills (Johnson et al., 2022). Additionally, Indicator 10 ("The instructional flow of the application supports conceptual understanding and skill development") indicates that the sequence of lessons helps learners develop knowledge progressively. A structured instructional flow supports scaffolded learning by allowing learners to build understanding step-by-step (Santos et al., 2023).

The lowest-rated indicators were Indicator 1 ("The explanations provided in the application are clear and accurate") and Indicator 2 ("The visuals and examples provided in the application help learners understand the topic better"). These indicators obtained mean scores of M = 4.53, with SD = 0.52 and SD = 0.64, respectively, both interpreted as Very High. Although these indicators obtained the lowest mean scores, they still represent a very high level of content quality. The results suggest that the explanations, visuals, and examples effectively support the understanding of Gas Laws concepts. According to Lopez and Garcia (2023), multimedia visuals and examples improve conceptual understanding by helping learners visualize abstract scientific relationships.

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Overall, the results indicate that GasApp Buddy achieved a Very High level of content quality (M = 4.75, SD = 0.37). The consistently high ratings across all indicators demonstrate that the instructional content is accurate, curriculum-aligned, pedagogically appropriate, and clearly presented. These findings confirm that GasApp Buddy serves as a high-quality supplementary instructional tool for teaching Gas Laws in General Chemistry 1.

Table 3

Level of Content Quality of GasApp Buddy as Evaluated by the Validators

Item	Statement	SD	M	Interpretation
1	The explanations provided in the application are clear and accurate.	0.52	4.53	Very High
2	The visuals and examples provided in the application help learners understand the topic better.	0.64	4.53	Very High
3	The quiz questions included in the application are aligned with the concepts taught in class.	0.00	5.00	Very High
4	The instructional content of the application is aligned with the prescribed chemistry curriculum.	0.00	5.00	Very High
5	The application uses language that is clear and easy for learners to understand.	0.00	5.00	Very High
6	The instructional content presented in the application is scientifically accurate.	0.51	4.60	Very High
7	The instructional approach used in the application is pedagogically appropriate for the learners.	0.51	4.60	Very High
8	The explanations and examples provided in the application are age-appropriate and contextually relevant.	0.51	4.60	Very High
9	The assessment items reflect the appropriate cognitive levels required in Gas Laws instruction.	0.51	4.60	Very High

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Item	Statement	SD	M	Interpretation
10	The instructional flow of the application supports conceptual understanding and skill development.	0.51	4.60	Very High

Likert Scale: 1.00–1.49 Very Low | 1.50–2.49 Low | 2.50–3.49 Moderate | 3.50–4.49 High | 4.50–5.00 Very High

Level of Technical Reliability of GasApp Buddy as Evaluated by the Validators

Table 4 presents the level of technical reliability of GasApp Buddy as evaluated by 15 validators, including chemistry teachers, master teachers, and application developers. The results reveal that GasApp Buddy obtained an area mean of M = 4.54 (SD = 0.52), interpreted as Very High. This indicates that the application functions reliably and performs consistently across different Android devices. The findings suggest that GasApp Buddy meets the technical requirements necessary for effective use as a supplementary instructional material in General Chemistry 1.

The highest-rated indicator was Indicator 7 ("The application maintains stable performance during prolonged use"), which obtained a mean score of M = 5.00 (SD = 0.00), interpreted as Very High. This result indicates unanimous agreement among validators that the application maintains consistent performance even when used for extended periods. Stable performance is a critical requirement for educational mobile applications because interruptions or slowdowns may negatively affect learner engagement and learning continuity. According to Gomez and Santos (2024), reliable system performance ensures uninterrupted access to instructional materials, particularly in offline learning environments.

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The next highest indicators were Indicator 1 ("The application functions reliably across different Android devices") and Indicator 5 ("No major bugs or crashes were observed during the testing of the application"), both of which obtained M = 4.60 (SD = 0.51), interpreted as Very High. These results indicate that GasApp Buddy operates consistently across different devices and runs without significant technical problems. Cross-device compatibility is essential in mobile learning environments because learners often use various smartphone models with differing technical specifications (Chen & Santos, 2022). Furthermore, the absence of major bugs or crashes suggests that the application was properly developed and tested prior to evaluation.

The next group of indicators obtained mean scores of M = 4.53, interpreted as Very High; this group includes Indicators 3, 4, 6, 8, and 9, with standard deviations ranging from SD = 0.52 to SD = 0.64. Indicator 3 ("The offline access feature of the application is stable and functional") indicates that the application can be used effectively without internet connectivity. Offline capability is vital for accessibility in areas with limited internet access (Gomez & Santos, 2024). Indicator 4 ("The application loads promptly upon starting") indicates that the application starts quickly, allowing learners to access lessons without delay. Fast loading times improve usability and reduce learner frustration (Lee, 2023).

Similarly, Indicator 6 ("The simulations and interactive features run smoothly within the application") indicates that the interactive components of GasApp Buddy operate efficiently. Smooth simulations are important in chemistry learning because they allow learners to visualize abstract Gas Laws relationships without technical interruptions (Kumar et al.,

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2022). Indicator 8 ("Application updates and patches install without technical problems") indicates that improvements can be implemented successfully, supporting long-term maintainability (Chen & Santos, 2022). Indicator 9 ("User progress and scores are stored accurately by the application") indicates that learner records are saved correctly, which allows for effective progress monitoring (Johnson et al., 2022).

The lower-rated indicators were still interpreted as High, including Indicator 10 ("Multimedia elements such as images, animations, and graphics display correctly"), which obtained M = 4.33 (SD = 0.72), and Indicator 2 ("The modules and activities load properly without technical errors"), which obtained M = 4.20 (SD = 0.77). Although these ratings are lower than the others, they still represent positive evaluations. These results suggest that while multimedia elements and loading functions operate effectively, they offer opportunities for further refinement. According to Lee (2023), multimedia optimization is necessary to ensure a consistent display across devices with different screen resolutions and processing capabilities. Overall, the results indicate that GasApp Buddy achieved a Very High level of technical reliability (M = 4.54, SD = 0.52)

Table 4

Level of Technical Reliability of GasApp Buddy as Evaluated by the Validators

Item	Statement	SD	M	Interpretation
1	The application functions reliably across different Android devices.	0.51	4.60	Very High
2	The modules and activities load properly without technical errors.	0.77	4.20	High

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Item	Statement	SD	M	Interpretation
3	The offline access feature of the application is stable and functional.	0.52	4.53	Very High
4	The application loads promptly upon starting.	0.52	4.53	Very High
5	No major bugs or crashes were observed during the testing of the application.	0.51	4.60	Very High
6	The simulations and interactive features run smoothly within the application.	0.52	4.53	Very High
7	The application maintains stable performance during prolonged use.	0.00	5.00	Very High
8	Application updates and patches install without technical problems.	0.52	4.53	Very High
9	User progress and scores are stored accurately by the application.	0.64	4.53	Very High
10	Multimedia elements such as images, animations, and graphics display correctly.	0.72	4.33	High

Likert Scale: 1.00–1.49 Very Low | 1.50–2.49 Low | 2.50–3.49 Moderate | 3.50–4.49 High | 4.50–5.00 Very High

Level of Instructional Value of GasApp Buddy as Evaluated by the Validators

Table 5 presents the level of instructional value of GasApp Buddy as evaluated by 15 validators, including chemistry teachers, master teachers, and application developers. The results reveal that GasApp Buddy obtained an area mean of M = 4.76 (SD = 0.36), interpreted as Very High. This indicates that the application provides strong instructional support for the teaching and learning of Gas Laws in General Chemistry 1. These findings suggest that GasApp Buddy is pedagogically sound and can effectively function as a supplementary instructional material for Senior High School learners.

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The highest-rated indicators were Indicator 3 ("The application supports differentiated instruction and remediation activities"), Indicator 5 ("GasApp Buddy can be used as a supplementary material in Senior High School Chemistry"), and Indicator 9 ("The application encourages independent learning beyond classroom instruction"). All three indicators obtained a mean score of M = 5.00 (SD = 0.00), interpreted as Very High. These results indicate unanimous agreement among validators that GasApp Buddy effectively supports diverse learning needs and provides opportunities for remediation. The application allows learners to review lessons, repeat activities, and progress at their own pace, which facilitates differentiated instruction. Mobile learning environments are effective tools for differentiated learning because they allow learners to access content according to their individual needs and abilities (Ramlan & Nasir, 2023). Furthermore, the high rating for the application as a supplementary instructional material confirms that GasApp Buddy can effectively complement traditional classroom instruction, addressing the challenges identified in Chapter 1.

Similarly, the high rating for independent learning indicates that GasApp Buddy supports self-paced learning beyond classroom hours. Reyes and Lopez (2021) emphasized that mobile learning environments extend educational opportunities outside the classroom and promote continuous learning. This finding supports the primary objective of the study: to develop a mobile application that allows learners to study Gas Laws even without direct teacher supervision.

The remaining indicators obtained mean scores of M = 4.60 (SD = 0.51), all interpreted as Very High; this group includes Indicators 1, 2, 4, 6, 7, 8, and 10. Indicator 1 ("GasApp

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Buddy enhances learners' understanding of Gas Laws concepts") indicates that the application effectively supports conceptual learning. Interactive simulations and guided problem-solving activities help learners visualize pressure–volume–temperature relationships, which improves the understanding of abstract chemistry concepts (Lopez & Garcia, 2023; Kumar et al., 2022). Indicator 2 ("The application can be effectively integrated into classroom instruction") suggests that GasApp Buddy aligns well with existing teaching practices. Curriculum-aligned materials improve the integration of digital tools into formal instruction (Ramlan & Nasir, 2023).

Additionally, Indicator 4 ("The application complements teacher-led instructional strategies and lesson plans") indicates that GasApp Buddy supports teachers in delivering lessons more effectively. Supplementary materials help teachers reinforce concepts and provide additional practice opportunities (Reyes & Lopez, 2021). Indicator 6 ("The application provides learning experiences that promote higher-order thinking skills") indicates that the activities encourage analytical and problem-solving abilities. Guided simulations promote deeper understanding by requiring learners to apply Gas Laws concepts to varied situations (Johnson et al., 2022).

Indicator 7 ("GasApp Buddy effectively addresses common misconceptions about Gas Laws") indicates that the application helps learners correct misunderstandings through interactive simulations and real-time feedback (Lopez & Wu, 2024). Indicator 8 ("The activities promote mastery of both conceptual and computational skills") confirms that GasApp Buddy supports theoretical relationships alongside numerical calculations (Johnson et al., 2022).

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Finally, Indicator 10 ("The overall instruction enhances learners' understanding of the Gas Laws") indicates that the application provides a comprehensive learning experience. Overall, the results indicate that GasApp Buddy achieved a Very High level of instructional value (M = 4.76, SD = 0.36). The consistently high ratings across all indicators demonstrate that the application effectively supports teaching and learning, promotes independent study, and enhances conceptual mastery.

Table 5

Level of Instructional Value of GasApp Buddy as Evaluated by the Validators

Item	Statement	SD	M	Interpretation
1	GasApp Buddy enhances learners' understanding of Gas Laws concepts.	0.51	4.60	Very High
2	The application can be effectively integrated into classroom instruction.	0.51	4.60	Very High
3	The application supports differentiated instruction and remediation activities.	0.00	5.00	Very High
4	The application complements teacher-led instructional strategies and lesson plans.	0.51	4.60	Very High
5	GasApp Buddy can be used as a supplementary material in Senior High School Chemistry.	0.00	5.00	Very High
6	The application provides learning experiences that promote higher-order thinking skills.	0.51	4.60	Very High
7	GasApp Buddy effectively addresses common misconceptions about Gas Laws.	0.51	4.60	Very High
8	The activities promote mastery of both conceptual and computational skills.	0.51	4.60	Very High
9	The application encourages independent learning beyond classroom instruction.	0.00	5.00	Very High

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Item	Statement	SD	M	Interpretation
10	The overall instruction enhances learners' understanding of the Gas Laws.	0.51	4.60	Very High

Likert Scale: 1.00–1.49 Very Low | 1.50–2.49 Low | 2.50–3.49 Moderate | 3.50–4.49 High | 4.50–5.00 Very High

Overall Evaluation of GasApp Buddy

Table 6 presents the summary of the overall evaluation of GasApp Buddy based on five major criteria: ease of use, engagement, content quality, technical reliability, and instructional value as assessed by 15 validators. The results reveal that GasApp Buddy obtained consistently high ratings across all evaluation areas, with all variables interpreted as Very High. This indicates that the application is highly acceptable as a supplementary instructional material for Gas Laws in General Chemistry 1.

Among the five variables, Instructional Value obtained the highest rating (M = 4.76, SD = 0.36), interpreted as Very High. This result indicates that GasApp Buddy provides meaningful learning experiences that enhance learners' conceptual understanding of Gas Laws and support effective classroom instruction. The high instructional value suggests that the application successfully addresses the challenges identified in Chapter 1, particularly the difficulty learners experience in understanding abstract pressure–volume–temperature relationships. These findings support the view of Reyes and Lopez (2021) that mobile learning applications enhance conceptual understanding when they combine structured lessons with interactive activities. Similarly, Johnson et al. (2022) emphasized that well-designed

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instructional applications improve both conceptual understanding and problem-solving skills in chemistry.

The second-highest rating was obtained by Content Quality (M = 4.75, SD = 0.37), interpreted as Very High. This indicates that the instructional materials included in GasApp Buddy are accurate, curriculum-aligned, and appropriate for Senior High School learners. The high rating for content quality suggests that the application effectively supports the competencies required in the DepEd General Chemistry 1 curriculum. Curriculum-aligned instructional materials strengthen the integration of digital tools into classroom instruction and improve learning outcomes (Ramlan & Nasir, 2023). The results also support the findings of Lopez and Garcia (2023) that clear explanations and well-designed materials enhance conceptual understanding in mobile learning environments.

The next-highest rating was obtained by Engagement (M = 4.64, SD = 0.43), interpreted as Very High. This indicates that GasApp Buddy effectively promotes learner interest and motivation through interactive simulations, quizzes, multimedia elements, and gamified activities. The high engagement rating suggests that learners are likely to remain actively involved while using the application. Interactive mobile learning environments improve motivation and participation by allowing learners to explore concepts through simulations and guided activities (Santos & Velasco, 2024). These results support the theoretical framework of the study—specifically Self-Determination Theory—which emphasizes that motivation increases when learners experience autonomy and competence (Patel & Chen, 2024).

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The variable Ease of Use obtained a mean of M = 4.55 (SD = 0.55), interpreted as Very High, indicating that GasApp Buddy is user-friendly and easy to operate. The high usability rating suggests that learners can navigate the application efficiently without requiring technical assistance. Intuitive interface design and organized navigation structures improve learning efficiency, allowing learners to focus on instructional content rather than operation (Lee, 2023). These findings confirm that GasApp Buddy meets the usability requirements of effective educational mobile applications.

Finally, Technical Reliability obtained a mean of M = 4.54 (SD = 0.52), interpreted as Very High. While this was the lowest rating among the five variables, it still indicates a highly acceptable level of technical performance. The results suggest that the application functions reliably across Android devices and supports stable offline learning. Technical reliability is essential because consistent performance ensures uninterrupted access to content (Gomez & Santos, 2024). Although this variable obtained the lowest mean score, the rating confirms that GasApp Buddy performs effectively and meets the technical requirements for classroom use.

Overall, the results indicate that GasApp Buddy received an overall Very High evaluation across all variables, demonstrating that the application is usable, engaging, instructionally valuable, technically reliable, and academically sound. The findings confirm that GasApp Buddy is a highly acceptable supplementary instructional material for teaching Gas Laws and successfully addresses the instructional needs identified in Chapter 1.

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Table 6

Summary of the Overall Evaluation of GasApp Buddy

Variable	SD	M	Interpretation
Ease of Use	0.55	4.55	Very High
Engagement	0.43	4.64	Very High
Content Quality	0.37	4.75	Very High
Technical Reliability	0.52	4.54	Very High
Instructional Value	0.36	4.76	Very High

Likert Scale: 1.00–1.49 Very Low | 1.50–2.49 Low | 2.50–3.49 Moderate | 3.50–4.49 High | 4.50–5.00 Very High

Differences in the Ease of Use, Engagement, Content Quality, Technical Reliability, and Instructional Value of GasApp Buddy according to Validator Group

Table 7 presents the One-Way Analysis of Variance (ANOVA) results examining whether there is a significant difference in the evaluation of GasApp Buddy when grouped according to validator group—specifically, chemistry teachers, master teachers, and application developers—across five criteria: ease of use, engagement, content quality, technical reliability, and instructional value.

The results show that for ease of use, the computed *F*-value is 0.42 with a *p*-value of .664 ($F = 0.42$, $p = .664$), which is greater than the significance level of .05. This indicates that there is no significant difference in the evaluation of ease of use among the three groups of validators. This finding suggests that the interface design and navigation structure of GasApp Buddy are consistently perceived as user-friendly by both educators and developers.

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Effective interface design is essential in educational mobile applications because it enables learners to interact with instructional content more efficiently. According to Lee (2023), well-designed user interfaces and intuitive navigation structures significantly improve the usability of educational mobile applications in science learning environments.

For engagement, the ANOVA results revealed $F = 0.47$ with $p = .635$, which is also greater than the significance level of .05. This indicates that there is no statistically significant difference in the engagement ratings among the validator groups. The consistency of these evaluations implies that the interactive features of GasApp Buddy effectively support learner motivation and participation. Interactive simulations and multimedia elements are known to enhance student engagement in chemistry. Studies by Lopez and Garcia (2023) and Santos and Velasco (2024) emphasize that interactive mobile learning tools significantly increase learner participation and conceptual exploration in chemistry education.

In terms of content quality, the computed *F*-value is 0.34 with a *p*-value of .718 ($F = 0.34$, $p = .718$), indicating that there is no significant difference among the validators' assessments. This result suggests that the instructional materials provided in GasApp Buddy are consistently recognized as accurate, relevant, and aligned with the curriculum by all groups of evaluators. Curriculum alignment is a key factor in the effectiveness of educational technologies. Ramlan and Nasir (2023) highlighted that mobile learning applications contribute to improved learning outcomes when their instructional content supports curriculum competencies and structured learning objectives.

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For technical reliability, the ANOVA results yielded $F = 0.45$ with $p = .648$, which is also greater than .05. This indicates that the three groups of validators share similar perceptions regarding the stability and functionality of the application. Reliable performance is a critical requirement for mobile learning applications, particularly those designed for offline use. Chen and Santos (2022) explained that offline educational applications rely on efficient local database engines to maintain functionality without internet connectivity. Similarly, Gomez and Santos (2024) emphasized that stable technical frameworks and efficient caching mechanisms are necessary to ensure uninterrupted access to learning materials.

Finally, for instructional value, the ANOVA result showed $F = 0.39$ with $p = .687$, which again exceeds the significance level of .05. This indicates that there is no statistically significant difference in the evaluation of instructional value among chemistry teachers, master teachers, and application developers. The consistent evaluation across validator groups suggests that GasApp Buddy is widely recognized as an effective instructional tool for teaching Gas Laws. Digital learning applications that integrate structured instruction, interactive activities, and feedback mechanisms have been shown to significantly enhance conceptual understanding and learning outcomes (Johnson et al., 2022; Lopez & Wu, 2024).

Overall, the ANOVA results indicate that all validator groups provided consistent evaluations across all five criteria, suggesting that GasApp Buddy meets both pedagogical and technical standards. The absence of significant differences among the groups strengthens the credibility of the evaluation results and confirms the high acceptability of the application as a supplementary instructional material. This finding supports the assertion of Aunzo Jr. (2025)

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that well-designed educational technologies play an important role in advancing STEM education by combining instructional effectiveness with innovative technological solutions

Table 7

One-Way ANOVA Results on the Evaluation of GasApp Buddy According to Validator Group

Criteria	Source of Variation	SS	df	MS	F	p-value	Interpretation
Ease of Use	Between Groups	0.048	2	0.024	0.42	0.664	Not Significant
	Within Groups	0.689	12	0.057			
	Total	0.737	14				
Engagement	Between Groups	0.056	2	0.028	0.47	0.635	Not Significant
	Within Groups	0.721	12	0.060			
	Total	0.777	14				
Content Quality	Between Groups	0.039	2	0.020	0.34	0.718	Not Significant
	Within Groups	0.706	12	0.059			
	Total	0.745	14				
Technical Reliability	Between Groups	0.051	2	0.026	0.45	0.648	Not Significant
	Within Groups	0.689	12	0.057			
	Total	0.740	14				
Instructional Value	Between Groups	0.044	2	0.022	0.39	0.687	Not Significant
	Within Groups	0.682	12	0.057			
	Total	0.726	14				

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CONCLUSION

Based on the findings of the study, the following conclusions were drawn:

The development of GasApp Buddy demonstrates that a curriculum-aligned mobile application for Gas Laws instruction in General Chemistry 1 can be successfully implemented by adhering to appropriate multimedia design principles and mobile learning frameworks.

The application achieved a very high level of ease of use, indicating that it is user-friendly and capable of being operated independently by senior high school learners.

Furthermore, GasApp Buddy exhibited a very high level of engagement, effectively sustaining learner interest and motivation through its interactive and multimedia features.

The content quality was also rated as very high, confirming that the instructional materials are accurate, curriculum-aligned, and pedagogically appropriate for the target audience.

From a technical standpoint, the application proved to be highly reliable, functioning consistently across devices and supporting stable offline learning. Additionally, its very high instructional value indicates that it effectively enhances conceptual understanding while providing robust support for classroom instruction.

Most notably, the evaluations remained consistent across different groups of validators; since all p-values were greater than the 0.05 level of significance, the null hypothesis—stating that there is no significant difference in the evaluation based on the validator group—is accepted. This statistical consensus confirms that the application meets both the pedagogical and technical standards of subject matter experts and developers alike, establishing GasApp

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Buddy as a highly acceptable supplementary instructional material for teaching Gas Laws in General Chemistry 1.

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