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Android-Based Inquiry Activities on Gas Laws Using Smart Apps Creator for Grade 10 Learners

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ABSTRACT

Science education in the Philippines encounters notable difficulties, especially in the field of physics, where students often find it hard to grasp complex concepts like the Gas Laws. A major factor contributing to this struggle is the reliance on traditional teaching methods, which predominantly involve passive learning techniques. These approaches fail to actively engage students, making it harder for them to connect with and understand the material. Moreover, the scarcity of resources, such as modern equipment and teaching aids, further exacerbates the problem. As a result, students' interest in the subject wanes, leading to a decline in their academic performance and overall achievement in physics. To improve the situation, there is a clear need for more dynamic and interactive teaching strategies that encourage student participation, alongside better access to educational resources. Hence, this study dives into the creation of Android-based inquiry activities, aimed at teaching the intriguing concepts of Gas Laws. It incorporates PhET simulations which transform abstract concepts into interactive, visually-rich experiences. The development journey followed the Successive Approximation Model (SAM) framework, with feedback from Content and ICT validators, fueling multiple versions of the physics learning material The developed android-inquiry activities received a "Very Good" rating from the learners with an increment of learning 0.52 corresponding to moderate normalized gain indicating that the android-based learning material successfully covers relevant aspects of the curriculum. The Android-based inquiry activities on Gas Laws significantly improved Grade 10 STEM students' performance, raising their achievement from "did not meet expectations" to "very satisfactory." Both content and ICT experts rated it as "satisfactory," while students found it "very useful," highlighting its positive impact on learning. Therefore, this study highlights the potential of these Android-inquiry activities to turn Gas Laws into a captivating and digestible topic.

Key Words: Android-based Learning, Guided-Inquiry, Gas Laws, Physics Education, Normalized Gain.

1. INTRODUCTION

Physics is an important subject in education, but its application in learning media is often neglected. Physics is a science that studies natural phenomena (objects) both micro and macro and their interactions and tries to find relationships between these symptoms and the existing reality. However, a problem in physics learning in various countries is the assumption that physics is not an exciting subject, hard to understand and boring (Putri, 2021). Some factors that lead to the assumption are the increasing of student's motivation and interest, and the use of learning media that is not suitable. Some factors that cause student's interest in learning science (physics, chemistry, biology) become low are teaching strategies used by the teacher that do not relate the materials to the phenomena in the surroundings, teacher-centered learning that put the teacher as the primary knowledge resource, reflection during the learning process that still less optimal (Nasution R, Silaban S, & Sudrajat A., 2015). Hence, to make it easier for students to understand physics lessons easily, students need good learning media. According to Ikhbal and Musril (2020) state that learning media is a means of channeling messages or learning information that the source of the message wants to convey to the target or recipient of the message. One of the media that is suitable for use by students in this digital era is Android-based media because it has a big impact on students' ability to learn and understand physics concepts. According to Safitri et al., (2020), each concept does not stand alone but is interconnected with other concepts. In this era, Android-based media allows students to access educational content on their mobile phones, thus teachers must upgrade their competencies to deal with the millennial generation who are no strangers to the digital world (Surani, 2019). There are many Android-based learning support software applications available and one of them is the Smart Apps Creator (SAC). The Smart Apps Creator (SAC) application is the latest digital interactive media that builds multimedia content that can be installed on Android-based smartphones (Suhartini, 2021). Smart Apps Creator (SAC) as software has advantages including 1) does not require programming skills, so anyone can operate it, 2) The output of this application can be applied on various platforms and one of them is Android, 3) Easy to insert animation as desired and needs, 4) interactivity, 5) support for all types of storage media, 6) integrated web services so that applications are more functional (Budyastomo, 2020). Since Physics lessons consist of many concepts and material that is abstract in nature, making it difficult for students to understand, with the right learning media, students can gain a better understanding of physics and apply it in everyday life. Unfortunately, many learning media are not designed to help students understand Gas law concepts. Gas laws are a fundamental topic in both physics and chemistry, as they describe the behavior of gases under various conditions of temperature, pressure, and volume. A widely studied and foundational reference in this domain is "Boyle's Law, Charles's Law, Gay-Lussac's Law, and the Ideal Gas Law". These laws, are part of Thermodynamics, and Kinetic Theory, which are essential areas of physics, they help explain, and predict the macroscopic behavior gases, based on molecular motion and interactions. The research emphasizes the use of the Ideal Gas Law (PV=nRT) as a unifying equation in physics. It also connects these principles to real-world phenomena, such as the behavior of gases in engines, balloons, and atmospheric physics. Linking gas laws to thermodynamic processes helped in explaining key physics concepts like work, heat, and energy, (Doe, J., & Smith, A., 2018). Gas Law has been found to be difficult for both high school and college students to fully comprehend because it demands an understanding of particle behaviour at the microscopic level and encompasses the use of direct and inverse ratios, which require proportional reasoning, the capacity to identify and control variables, and probabilistic thinking. Because gas laws can only be explained in terms of other ideas (temperature, pressure, and volume), abstract qualities, and mathematical connections, these reasoning abilities are critical for grasping the concepts involved.

Therefore, this study initiated to evaluate the usage of physics learning medium that can aid students in enhancing scientific learning outcomes among 10th grade students. It is hoped that employing guided-inquiry activities with integrated PhET simulations would improve students' grasp of the topic of gas laws and inspire learning. The study's purpose was to provide Grade 10 Learners with effective learning material that would help them build their digital literacy and critical thinking skills in response to time constraints, as well as to boost their involvement in the process.

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2. METHODS

2.1 Research Design

This study used a Research and Development method with quantitative and qualitative data support. This technique was ideal for the goal of this study, which seeks to determine the impact of developing guided-inquiry activities on students' knowledge and motivation to learn gas laws.

Table 1. Research design of one group pre-test and post-test

Pre-test	Treatment	Post-test
O_1	X	O_2

As shown in Table 1, the research design employed in this study is a one group pre-test and post-test, which indicates that the researcher would only take an experimental group for measuring the groups' dependent variable (O1), which was commonly referred to as a pre-test. The pre-test was administered to the subject using a series of questions. The following stage was to do an experimental manipulation (X). After the intervention, the post-test (O2) subsequently be performed.

2.2 Research Participants

An intact section of 10th-grade students from a Public Junior High School in Hinaplanon, Iligan City, Lanao Del Norte, was the primary target audience of the learning material. These students were currently enrolled in physics courses for the School Year 2024-2025, making them well-suited to provide firsthand feedback on how the material supports their learning. Their responses reflected the relevance, clarity, and engagement level of the content from a learner's perspective. Moreover, the evaluation process involves a carefully selected and diverse group of participants to ensure a comprehensive assessment of the learning material. This group includes science/physics teachers, ICT teachers, and learners, each contributing unique perspectives to the evaluation. By involving both experienced educators and actively engaged students, the evaluation process ensures a well-rounded and insightful review of the learning material. Hence, the combination of pedagogical, technological, and student-centered feedback contributes to refining and improving the educational resource, making it more effective, relevant, and user-friendly for future learners.

2.3 Data Gathering Procedure (Successive Approximation Model)

The researcher used Dr. Allen's (SAM) or Successive Approximation Model (2012), presented in Figure 1, to design and develop an android-based inquiry activities on gas laws. To ensure that the design process aligns with developmental research, the research and development (R&D) technique served as a structured approach to designing a product and assessing its efficacy. The Successive Approximation Model (SAM) enhances this process by offering a more flexible, iterative, and collaborative approach to instructional design. Unlike traditional linear models, SAM prioritizes rapid development, allowing for continuous feedback and adjustments throughout the design cycle. This ensures that e-learning materials were not only developed efficiently but also refined to meet learner needs effectively. SAM consists of three key stages: the Preparation Phase, Iterative design phase, Iterative development phase.

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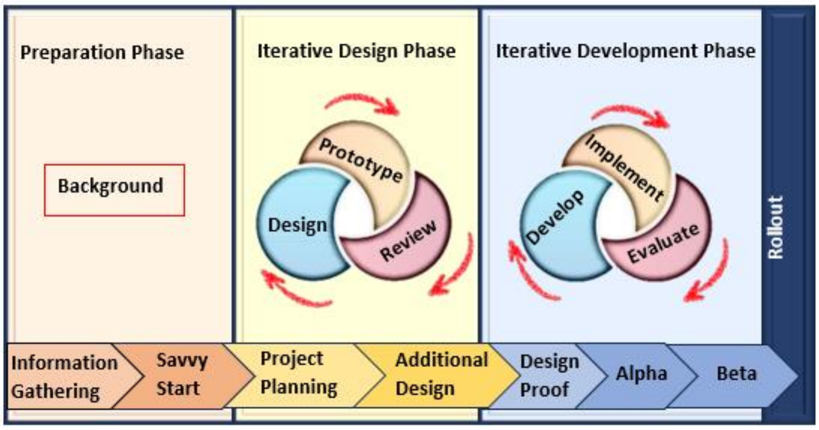

Figure 1. Process of SAM

2.3.1. Preparation Phase

SAM begins the preparation phase by gathering all relevant project information and background knowledge. This was known as a "savvy start." The savvy start acts as a starting point, allowing the researcher to examine the background information gathered and create preliminary ideas for building e-learning content. These studies explore various aspects of android-based learning and its influence on students' academic experiences. One key area of research focuses on the academic effects of mobile learning, examining how the use of mobile devices—such as smartphones, tablets, and educational apps—enhances knowledge retention, comprehension, and overall learning outcomes. Another significant area of study investigates the impact of mobile learning on students' motivation, analyzing how accessibility, interactivity, and personalized learning experiences influence student engagement, interest, and willingness to participate in the learning process. Additionally, researcher assessed the overall impact on students' performance, evaluating whether mobile learning contributes to improved grades, critical thinking skills, problem-solving abilities, and self-directed learning. These studies help educators and policymakers understand how mobile technology can be effectively integrated into the educational system to maximize its benefits while addressing potential challenges, such as distractions, digital divide issues, and the need for proper instructional design.

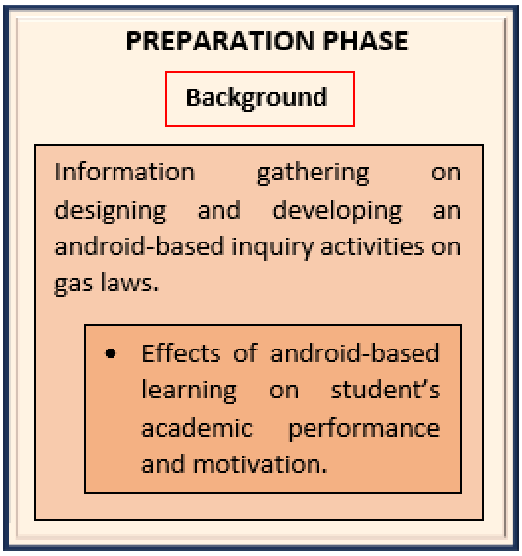

Figure 2. Preparation Phase

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2.3.2 Iterative Design Phase

Design

a. Project Planning

Before conducting the study, the researcher selected a science topic that aligned with the curriculum guide and was challenging for students to understand. The chosen topic is ***Gas Laws***, which include **three key components:** the ***kinetic molecular theory, volume-pressure-temperature relationship, and the ideal gas law.*** To ensure a structured and seamless learning experience, the researcher designed a **7E lesson plan** for each component. Additionally, the researcher developed an Android-based inquiry activities and a learning packet on gas laws, both aligned with the Department of Education (DepEd) K-12 Curriculum Standards and the Most Essential Learning Competencies (MELCs).

b. Additional Design

Android-Based Inquiry Activities

Making this android-based educational content makes teaching and learning more efficient, engaging and enjoyable for students. The following instructional content was designed:

1. Title Display- this display was the introductory video for learning media and was the first display of android-based media aided by smart app creator.

2. Topic Display- was the display of the topic, the learning content, content standard competencies that students must accomplish.

3. Set Up/ Instructions- was a display of instructions for using learning media to guarantee that students utilized learning media without difficulty.

4. Vodcast Display- a vodcast presentation that served as an interactive learning tool designed to enhance students' understanding of gas laws. It specifically focused on key topics, including the kinetic molecular theory, volume, pressure, and temperature relationship, and ideal gas law. Additionally, the vodcast integrates guided-inquiry activities, allowing students to actively engage with the concepts through structured explorations. To further reinforce learning, it also incorporates PhET simulations on gas laws, providing dynamic visual representations that help students experiment with gas properties in a virtual environment.

5.Quiz Display- Additionally, for the assessment of knowledge a short quiz was deployed to help assess how much students have understood and retained from the lessons. This gives a way to gauge students' progress and identify areas where they may need more help.

Guided Inquiry-Based Learning Packet- was a structured, hands-on student resource designed to facilitate a deeper understanding of gas laws through active exploration and critical thinking. This packet follows an inquiry-based approach, encouraging students to investigate key concepts, analyze data, and draw conclusions rather than passively receiving information. It covers fundamental topics such as:

- The Kinetic Molecular Theory of Gases – explaining the movement and behavior of gas particles.
- The Volume-Pressure-Temperature Relationship – exploring Boyle’s Law, Charles’ Law, and Gay-Lussac’s Law through interactive activities.
- The Ideal Gas Law – applying mathematical relationships to real-world gas behaviors.

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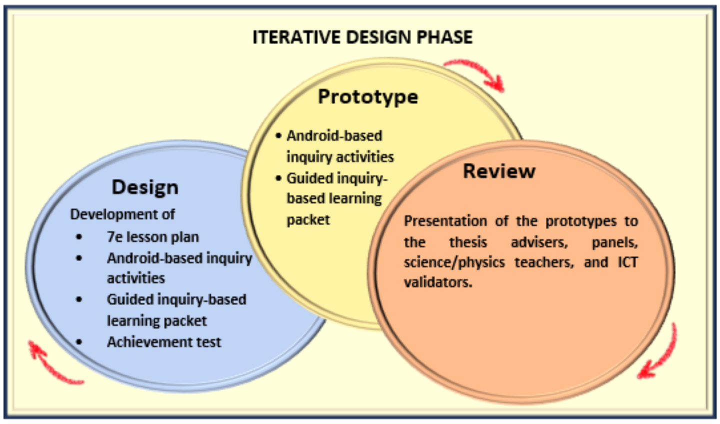

Figure 3. Iterative Design Phase

Prototype

The researcher designed an interactive, Android-based inquiry activities focused on gas laws to enhance student engagement and understanding. This digital resource includes structured lesson plans that guide learners through key concepts, collaborative group exercises that encourage discussion and critical thinking, problem sets that reinforce theoretical knowledge through application, and achievement tests to assess learning outcomes. Additionally, to assess students' understanding of the topic, the researcher developed a comprehensive manual that serves as both a learning guide and an assessment tool. This manual includes key concepts, step-by-step explanations, practice exercises, and self-assessment questions that allow students to track their progress. It provides structured activities designed to reinforce learning, such as conceptual questions, real-life applications of gas laws, and guided problem-solving exercises.

Review

The thesis advisers, panel members, science/physics teachers, and ICT validators were carefully evaluated the design and content of the developed Android-based inquiry activities, along with its accompanying manual, to ensure its effectiveness and alignment with educational standards. After their initial review, the researcher implemented the necessary revisions based on their feedback and recommendations. Additionally, the areas subjected to face validation by science and physics teachers, ICT experts, and learners include:
a.) The developed Android-based inquiry activities-ensuring their scientific accuracy, usability, and instructional effectiveness.
b.) The guided-inquiry activity learning packet-which serves as a structured resource to facilitate students' exploration of gas laws.

After this validation process, the instructional materials would be looped back to the previous stage for further refinement. Any additional revisions would be made according to the comments and suggestions provided by the reviewers, ensuring continuous improvement and the development of high-quality learning resources.

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2.3.3 Iterative Development Phase

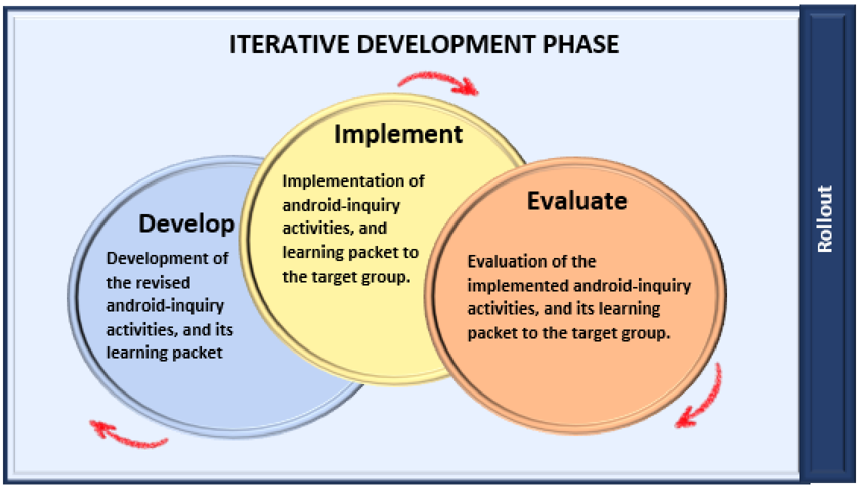

Figure 4. Iterative Development Phase

Finally, in the iterative development phase, the researcher cycled through development, implementation, and evaluation. The first cycle's product was a design proof, which was created at the start of the development phase. After showcasing and assessing the design proof, an alpha version was given out. After rolling out the alpha version, the researcher evaluated their feedback using a physics motivation survey questionnaire. This is a measure of the learners' perception in utilizing the android-based inquiry activities on gas laws. The normalized gain was also calculated as a measure of how much learning that the guided-inquiry activities may generate. The researcher then analyzed their responses which based on the five-point Likert scale-response, corresponds to the researcher-articulated physics motivation questionnaire descriptions. The following table provides a 5-point Likert Scale-scoring guide for the respondent's responses.

Table 2. Perception Scale for Students

Interval	Description
4:20– 5.00	Very Useful
3.40 – 4.19	Useful
2.60 – 3.39	Fairly Useful
1.80 – 2.59	Unuseful
1.00 – 1.79	Very Unuseful

2.4 Data Analysis

The following methods was used to analyze the observational data that the researchers collected.

a.) Normalized Gain

The normalized gain score (g) was computed to better understand the impact of the generated content on the success of grade 10 learners. Recommend employing normalized gain to compare pre- and post-instruction concept inventory scores. The normalized

gain score was calculated by dividing the difference between the posttest and pretest mean scores by the difference between the greatest achievable percentage score and the pretest percentage mean score. This was demonstrated by the following equation:

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$$<g> = \frac{(post\ test\ score - pre\ test\ score)}{(perfect\ score - pre\ test\ score)}$$

The normalized gain score and criterion table developed by Hake (1999) and quoted by Rani et al. (2017) is used in this investigation and are provided in Table 3 below. An Excel spreadsheet was also used to compute the normalized gain score.

Table 3. Normalized Gain Score and Criteria

Normalized Gain Score <g>	Criteria
0.70 < g	High
0.31 < g < 0.70	Moderate
g < 0.30	Low

b.) Mean

To determine the usefulness of the developed material. The Department of Education Grading Scale will be used to measure the grade scale of the pretest and posttest results.

Table 4. Descriptors, Grading Scale and Remarks

Descriptors	Grading Scale	Remarks
Outstanding	90-100	Passed
Very Satisfactory	85-89	Passed
Satisfactory	80-84	Passed
Fairly Satisfactory	75-79	Passed
Did not meet expectations	Below 75	Failed

3. RESULTS AND DISCUSSIONS

3.1 Preparation Phase

3.1.1 Development of Android-Based Inquiry Activities on Gas Laws

Before initiating the design and development process of the Android-Based Inquiry Activities, the most essential learning competencies presented in Table 5 were used as a preliminary basis. The overall design of the Android-Based Inquiry Activities, such as the duration and flow of the implementation, group activities, and achievement tests, were all anchored on these competencies.

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Table 5. Most Essential Learning Competencies for Grade 10 Science

Quarter	Content	Content Standard	Learning Competency	Duration	K-12 CG Code
4th	1. Gas Laws 1.1 Kinetic Molecular Theory 1.2 Volume, pressure, and temperature relationship 1.3 Ideal gas law	The learners demonstrate an understanding of.… how gases behave based on the motion and relative distances between gas particles	The learners should be able to… 1. investigate the relationship between: 1.1 volume and pressure at constant temperature of a gas; 1.2 volume and temperature at constant pressure of a gas; 1.3 explains these relationships using the kinetic molecular theory;	Week 1-2	S10MTIVa-b-21

The topic was supported by numerous research, each of which asserted a distinct theory concerning android-based inquiry activities. The researchers read the publications listed in table 6 below to aid in the production of the topic gas laws.

Table 6. Summary Of Previous & Related Studies

Title	Link	Findings	Limitations
Development of Android-Based Interactive Physics Learning Media for Gas Kinetic Theory Materials.	https://ijcsrr.org/single-view/?id=8107&pid=7828	The findings indicate that the developed Android-based interactive physics learning media is highly feasible for use based on expert and teacher evaluations. Students responded positively, finding it effective, productive, safe, and satisfying. Moreover, the learning media demonstrated a moderate level of effectiveness in enhancing students' conceptual understanding of physics concepts.	The study has limitations, including a small sample size from one school, short-term evaluation, and a narrow scope of physics topics. Being Android-based, it lacks cross-platform accessibility. It also does not deeply analyze student engagement or compare effectiveness with traditional methods. Expert evaluations may be subjective. Future research should expand the sample, assess long-term impact, ensure wider accessibility, and compare with other teaching strategies.
The Effectiveness of Android-Based Physics Learning	https://jpfis.unram.ac.id/index.php/jppfi/article/view/208	The study developed an Android-based physics learning media using smart app creators for mechanical wave material and tested its effectiveness with 22 students from SMAN 1 Gunungsari. The results	The study has several limitations. It involved only 22 students from a single school, limiting the generalizability of the findings. The evaluation focused on short-term learning gains without

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Media Assisted by Smart Apps Creator to Improve Learning Outcomes.		showed an improvement in learning outcomes, with the average pre-test score of 43.33 increasing to 72.50 in the post-test. The N-gain score of 0.52 indicates moderate effectiveness in enhancing students' understanding. These findings suggest that the developed learning media is effective in improving student learning in mechanical wave concepts.	assessing long-term retention. Additionally, the study covered only mechanical wave material, restricting its applicability to other physics topics. Since the learning media was designed for Android devices, accessibility on other platforms was not considered. Future research should expand the sample size, assess long-term effectiveness, and explore broader content coverage for wider applicability.
Physics Learning Using Guided Inquiry Models Based on Virtual Laboratories and Real Laboratories to Improve Learning.	https://ejournal.undiksha.ac.id/index.php/JLLS/article/view/61000/25882	The study found that using a guided inquiry learning model with both virtual and real experiments significantly improves students' physics learning outcomes. The experimental group, which used this method, achieved a higher average score (87.47) compared to the control group (69.72). Statistical analysis ($p = 0.000 < 0.05$) confirmed that this approach had a significant positive impact on learning.	The study was limited to 64 students from a single school, which may affect the generalizability of the results. It focused only on short-term learning gains without assessing long-term retention. Additionally, the study relied solely on test scores, without considering other factors like student engagement and conceptual understanding. Future research should involve a larger sample, assess long-term effects, and explore additional learning outcomes.
Effects of the Online Interactive Learning Media on Student's Achievement and Interest in Physics.	https://eprints.uad.ac.id/49367/1/Effects_of_the_Online_Interactive_Learni.pdf	The study developed interactive learning media using Lectora Inspire to enhance learning interest and achievement among eleventh-grade students. The media was validated by subject experts, media experts, and teachers using a Likert scale questionnaire. It was implemented in three classes (108 students), and its impact was analyzed using MANOVA. Results showed that integrating various digital media in a structured environment positively influenced student interaction, interest, and learning outcomes.	The interactive media was only accessible to students with a personal password, limiting broader usability. The study did not assess multiple learning performance indicators, media sequencing, or variations in media types. Future research should explore broader accessibility, diverse performance metrics, and varied media integration for enhanced learning impact.
Teaching and learning Physics using interactive simulation: A guided inquiry practice.	https://www.sajournalofeducation.co.za/index.php/saje/article/view/1997/1149	The study found that integrating Interactive Simulation Technology (IST) into inquiry-based activities significantly improved Grade 11 learners' conceptual understanding of electrostatics. The experimental group, which used IST, showed a greater gain in conceptual knowledge as measured by post-test results compared to the control group, which continued with traditional teaching methods. The statistical analysis (Mann-Whitney	The study was conducted in a single rural school in South Africa, which limits the generalizability of the findings to other contexts or regions. The sample size was relatively small ($n = 60$), and the random assignment might not account for all variables affecting learners' performance. The study primarily relied on quantitative measures (pre/post-tests), with qualitative data (observations and interviews) used to supplement,

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		U-test) revealed a significant difference in the post-test results, with the experimental group achieving a higher mean rank score (38.83) than the control group (22.17), indicating the effectiveness of IST in enhancing science learning.	but it may have lacked a deeper qualitative exploration of learners' experiences with IST.
A reflective study on adopting inquiry-based science teaching methods.	https://diser.springeropen.com/articles/10.1186/s43031-024-00119 3#:~:text=Studies%20has%20found%20IBL%20enhancing,et%20al.%2C%202018).	The study highlights that teachers' professional learning significantly influences their attitudes toward adopting Inquiry-Based Learning (IBL) in science education. Teachers with positive views of IBL, supported by their prior learning experiences, are more likely to implement it effectively in the classroom. The study found that teachers' professional growth is enhanced through collaboration in learning communities, reflective practices, and the development of Pedagogical Content Knowledge (PCK). Classroom discussions and reflections with students further contribute to teachers' ability to motivate students and facilitate meaningful learning. The findings emphasize the importance of integrating Inquiry-Based Science Education (IBSE) into teacher education programs to enhance teaching effectiveness and ongoing professional development.	The study is based on a self-study and autoethnographic approach, which can introduce bias due to its subjective nature and reliance on personal reflection. The study focuses on the author's individual experiences, which may not be representative of all teachers or generalizable to broader contexts. Limited data sources may restrict the depth of understanding of the overall impact of IBL on teaching practices, as it primarily relies on personal experiences and reflections rather than a diverse range of perspectives.

3.2 2 Iterative Design, Development, and Validation of the Course Material

a. Project Planning

To provide a well-organized and smooth learning experience, the researcher developed a 7E lesson plan for the topic of gas laws, which includes three sub-topics: Kinetic Molecular Theory, Volume-Pressure-Temperature Relationship, and the Ideal Gas Law. Below were the sample screenshots of the lesson plan.

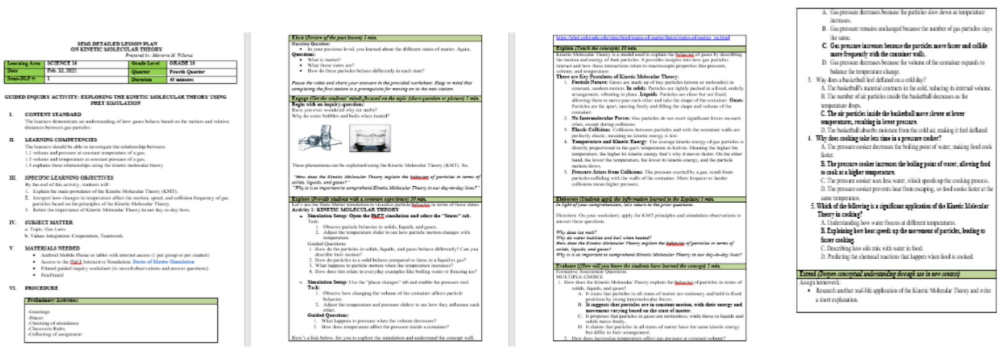

Figure 5. 7E Lesson Plan on Kinetic Molecular Theory

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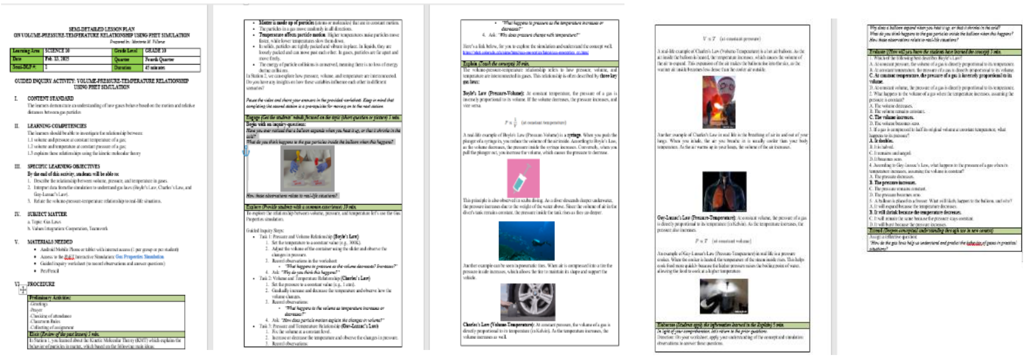

Figure 6. 7E Lesson Plan on Volume-Pressure-Temperature Relationship

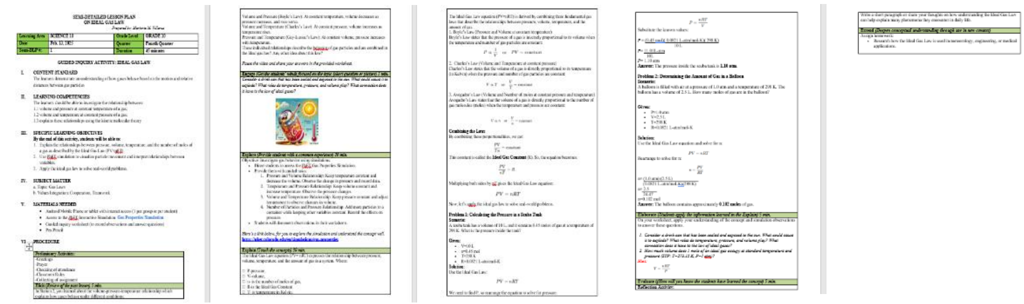

Figure 7. 7E Lesson Plan on Ideal Gas Law

b. Additional Design

Android-Based Inquiry Activities

During this phase, the alpha version of the android-based inquiry activities on gas laws was produced. This initial iteration of the course materials was basically the prototype in its functioning form. Additionally, the included vodcast lasted only 5–6 minutes to ensure the learners were not bored and for their own convenience. Below were the sample shoots of the first version of the android-based inquiry activities.

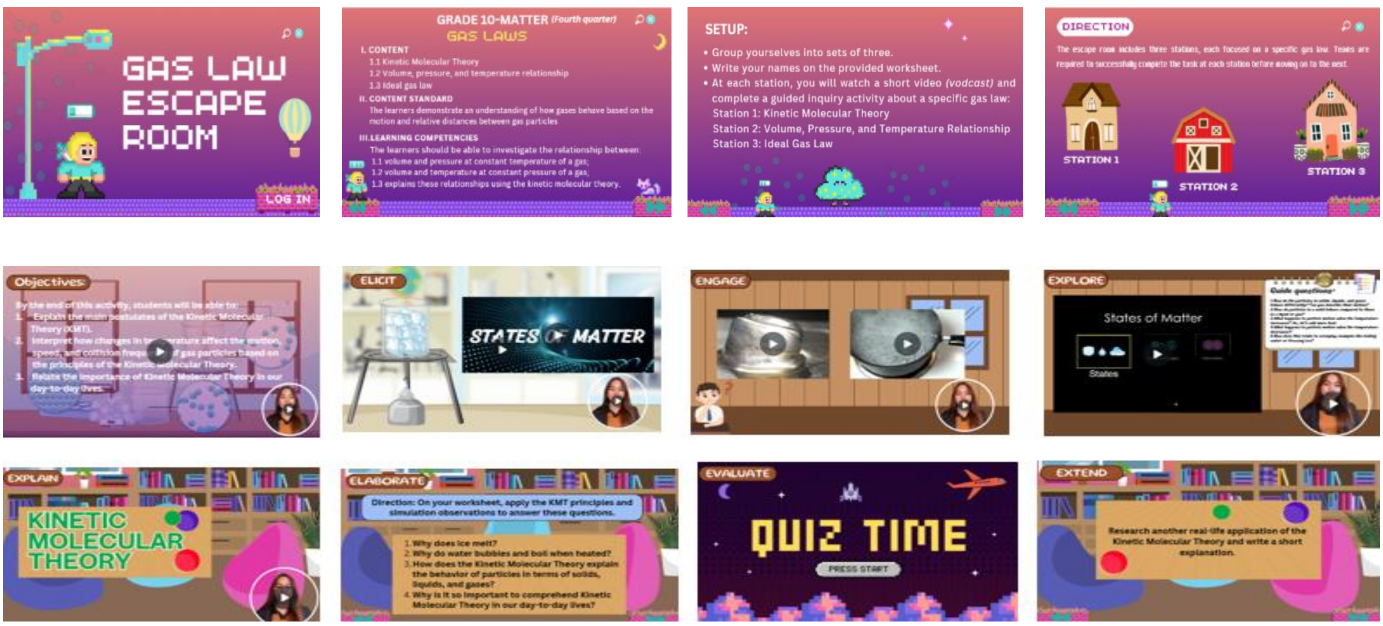

Figure 8. Sample Shoots of the Alpha Version of Android-Based Inquiry Activities on Gas Laws

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After showing the alpha version to the evaluators, the researchers took note of the comments and suggestions of the content/ICT validators so as to provide a better version of the course material. Thus, the following were the comments for improvements by the evaluators with their anonymous code:

Table 7. Content Validators' Comments and Suggestions

Code	Content	Action Taken
ST1	Please review for any grammatical errors. Ensure words are properly pronounced. Including "escape rooms" does not seem to enhance the video's engagement, as viewers must go through it linearly.	The researcher kept an eye out for pronunciation and grammar flaws, and the escape rooms were undoubtedly updated by the researcher to offer a captivating and immersive experience, which raised the video's overall appeal.
ST2	I like how the developed material is very appealing to the target age group, thus the chances of these students using these materials in class is high. It's interactive and engaging.	None
ST3	It is a very interactive learning materials which are suitable for learners nowadays aside from being an engaging learning trends to Grade 10 learners, it is also very informative, clear and organized.	None
ST4	Your Presentation is an interactive material where students may find it engaging.	None
ST5	I think the material captured its overall goal in providing a novel learning material for the students.	None

The evaluators' feedback and suggestions on the content were presented in Table 7. Overall, the comments were largely positive regarding the Android-based learning material. In response to the negative feedback, particularly concerning the speaker's delivery, the researcher addressed issues such as correcting grammar errors, improving pronunciation, and enhancing voice modulation to make the narration more engaging and effective in conveying the topic.

Table 8. ICT/Vodcast Validators' Comments and Suggestions

Code	Content	Action Taken
ICT1	Remove unnecessary designs and elements that can distract the reader.	The researcher removed the unnecessary designs and elements that can distract the reader.
ICT2	Given that the video lasts 18 minutes—which is quite long for an instructional video—it could be made more engaging by having the speaker adopt a more conversational tone, incorporating questions to help students connect the topic to real life, and adding more animations, particularly during problem-solving segments.	To enhance its effectiveness, the speaker adopted a more conversational tone, making the presentation feel less formal and more approachable. The researcher incorporated questions during key moments that could prompt students to think critically and relate the concepts to real-life scenarios, making the material feel more

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		relevant and practical. To further boost engagement, the researcher integrates more animations, to make them easier to understand.
ICT3	The graphics are good, and the overall presentation is very pleasing aesthetically. Overall, it provides a fun and interactive learning experience.	None
ICT4	Improve the audio and background noises.	The researcher identified and eliminated any background noise or irrelevant audio elements from the recordings to ensure clarity and focus on the main content.
ICT5	Diction should be more precise	The researcher used precise diction to avoid misunderstandings, and ensures that the message is focused and clear, to enhances the overall impact of the communication.
ICT 6	Nice graphics, the theme and design are appropriate for the idea of the game.	None
ICT 7	The technical production was good.	None

The evaluator's comments and suggestions on the technical aspects of the android-based learning material particularly the vodcast part were displayed in Table 8. Responses focused primarily on the vodcast's length, presentation, and background noises. In order to reduce unneeded noise, the researcher used an isolated space, revised with a shorter runtime, and used a uniformed background.

As a result, their initial feedback and recommendations served as the foundation for the revisions, which have now been incorporated. Therefore, below was the beta version of the Android-based learning material.

Figure 9. *Sample Shoots of the Beta Version of Android-Based Inquiry Activities on Gas Laws*

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As shown in Figure 9, the beta version of the android-based learning material already had the same background. The navigation buttons (next, back, and home) have been improved. It has a shorter runtime compared to the alpha version, and unnecessary background noise has been eliminated. The Vodcast was more concise, emphasizing simulations and diagrams that align with the MELCs. Grammar errors and speaker pronunciation have been improved. The vodcast discussion has been shortened and now focuses solely on the specific objectives outlined in the MELCs. The reduced duration addresses students' shorter attention spans, and it was also more compatible with students' often unreliable internet access and limited smartphone storage capacity.

Guided Inquiry-Based Learning Packet

In this phase, the first version of the Guided Inquiry-Based Learning Packet on gas laws was created. This initial version of the course material served as the prototype in its operational form. Below were sample images of the first version of the learning packet.

Figure 10. Sample Shoots of the First Version of Guided Inquiry-Based Learning packet

After showing the first version to the evaluators, the researchers took note of the comments and suggestions of the content/ICT validators so as to provide a better version of the learning packet. Thus, the following were the comments for improvements by the evaluators with their anonymous code:

Table 9. Evaluators' Comments and Suggestions on the Learning Packet

Code	Content	Action Taken
ST1	I believe the material successfully achieved its main goal of offering a unique learning resource for the students.	None
ST2	If I may suggest, the title a hands-on student guide to understanding gas laws could be improved by renaming it to "Exploring Gas Laws: A Guided Inquiry-Based Learning Packet."	The researcher applied his suggestion in renaming the title into "Exploring Gas Laws: A Guided Inquiry-Based Learning Packet."
ICT1	Get rid of unnecessary designs and features that may interfere with the reader's focus.	The researcher removed the unnecessary designs and elements that can interfere with the reader's focus.
ICT2	Last 4 items under Format are not applicable.	The researcher forsakes the last 4 items since it is not applicable.
ICT 3	There some paragraphs were not aligned or in "justified" alignment	To make the sentence clearer and more polished, the researcher

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	format.	rephrased it to improve readability, and fix the alignment format.
ST3	The learning packet is overly colorful, which could increase printing costs. It would be better to reduce the excessive design elements in the content section.	The researcher reduced the design elements in the content section, simplifying the graphics to make them less colorful and more straightforward.
ST4	There is some confusion with the numbering and the repeated activity numbers. I would suggest using this sequence: "Title, Introduction to the topic, Learning Competencies" for the content section, “Stations’ title, specific learning objectives, then activity then your continued 7e guided-inquiry activities with continued number. Apply the same format for the other stations.”	The researcher updated the learning packet, particularly in the content section, following the suggested format.
ST5	Why is the background of the content a house? Perhaps you could remove that element, as it doesn't relate to the topic.	The researcher eliminated the house element from the content section.

The evaluators' feedback and recommendations on the learning packet were shown in Table 9. The comments primarily focused on the format, numbering, displayed elements, alignment, colors, and renaming of title. In response, the researcher removed unnecessary elements and revised the learning material based on their suggestions to create a more engaging and effective learning packet for the students.

As a result, their initial feedback and suggestions formed the basis for the revisions, which have now been implemented. Thus, the second version of the Guided Inquiry-based learning packet was presented below.

Figure 11. Sample Shoots of the Final Version of Guided Inquiry-Based Learning packet

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As shown in Figure 11, the second version of the Guided Inquiry-Based Learning Packet has been enhanced. The title "A Hands-on Student Guide to Understanding Gas Laws" has been changed to "Exploring Gas Laws: A Guided Inquiry-Based Learning Packet." The researcher reduced the design elements in the content section, removing the house design and simplifying the visuals to make them less colorful and more straightforward. Additionally, the suggested format was followed to make the instructions clearer and more refined.

Moreover, the outcomes of the pretest and posttest were further examined to produce better results at this level. Knowing how the learning material affected the respondents' performance on the test, Gas laws. The normalized gain score includes the outcomes of the pretest and posttest calculation as thoroughly covered in the evaluation stage.

Table 10. Normalized Gain Score Analysis

Learner's Identity	Pretest Raw Score	Posttest Raw Score	Normalized Gain	Description
L1	12	18	0.46	Moderate
L2	14	20	0.55	Moderate
L3	17	19	0.25	Low
L4	15	19	0.40	Moderate
L5	12	17	0.38	Moderate
L6	16	23	0.78	High
L7	16	20	0.44	Moderate
L8	18	19	0.14	Low
L9	17	18	0.13	Low
L10	17	20	0.38	Moderate
L11	17	23	0.75	High
L12	12	24	0.92	High
L13	17	20	0.38	Moderate
L14	16	21	0.56	Moderate
L15	17	25	1.00	High
L16	15	20	0.50	Moderate
L17	15	20	0.50	Moderate
L18	17	21	0.50	Moderate
L19	16	24	0.89	High
L20	19	23	0.67	Moderate
L21	15	17	0.20	Low
L22	18	20	0.29	Low
L23	16	25	1.00	High
L24	15	17	0.20	Low
L25	12	13	0.08	Low
L26	16	24	0.89	High
L27	13	23	0.83	High
L28	17	25	1.00	High
L29	7	13	0.33	Moderate

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L30	18	20	0.29	Low
L31	18	23	0.71	High
L32	17	20	0.38	Moderate
L33	17	21	0.50	Moderate
L34	18	19	0.14	Low
L35	17	24	0.88	High
L36	16	20	0.44	Moderate
L37	14	16	0.18	Low
L38	9	11	0.13	Low
L39	12	16	0.31	Moderate
L40	17	24	0.88	High
L41	18	25	1.00	High
L42	18	25	1.00	High
L43	13	24	0.92	High
L44	17	22	0.63	Moderate
L45	17	18	0.13	Low
L46	12	15	0.23	Low
L47	18	22	0.57	Moderate
Overall Mean	**15.53**	**20.34**	**0.52**	**Moderate**

As shown in Table 10, fifteen (15) got a high normalized gain, nineteen (19) got moderate and thirteen (13) had a low normalized gain. Overall, the respondents posted a uniform moderate gain score on the topic Gas Laws. The overall pretest mean score was 15.53 while the overall posttest mean score was 20.34. Using the normalized gain score formula shown in chapter 3, the overall normalized gain score is computed to be 0.52 and is level as moderate. This means, that interactive learning multimedia has advantages, one of which is being able to make learning innovative, effective, creative, and efficient (Septiani et al., (2020); Wong & Adesope, (2021). Besides that, the advantages of learning multimedia make it easy for users to operate it, especially at time and place, meaning that there was interactivity between students and the multimedia used. It also enhances inquiry-based learning because in this approach students actively discover information by allowing scientific discovery within realistic setting (de Jong,2006). It was an educational tool which offers students the unique opportunity of experiencing and exploring broader environments, objects, and phenomena within the walls of the classroom wherein students can observe and manipulate normally inaccessible objects, variables, and processes in real-time (Strangman et al., 2021). Therefore, it can be concluded that learning multimedia can be a solution to facilitate teachers in forming students' conceptual understanding of Gas Laws.

Moreover, during this stage, the learning material evaluation survey questionnaire was further analyzed towards a better understanding of the influence of android-based inquiry activities from the respondents' perception. Hence, the following table was the learning material evaluation survey result of the learners.

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Table 11. Descriptive Evaluation of the Respondents on the Developed Android-Inquiry Activities

Items	Weighted Mean	Interpretation
CLARITY		
1. Sentences and paragraph structures are varied and interesting.	4.05	Good
2. Simple and can be easily recognize.	4	Good
3. Instructions on how to use the learning material are clear.	4.54	Very Good
4. The learning material has high artistic quality and literary style.	4.32	Very Good
5. Length of sentences is suited to my comprehension level.	4.16	Good
Average Mean	**4.21**	**Very Good**
RELEVANCE		
1. The lessons were presented at a pace that allows me to reflect and review each particular lesson.	4.27	Very Good
2. Learning material provides for the development of higher cognitive skills such as critical thinking, creativity, learning by doing, inquiry, etc.	4.41	Very Good
3. Learning materials is free of ideological, cultural, religious, racial and gender biases and prejudices.	4.19	Good
4. The learning material presented the most important aspects of the topics to be taught.	4.49	Very Good
5. Learning material enhances development of desirable values and traits.	4.35	Very Good
Average Mean	**4.34**	**Very Good**
ENGAGEMENT		
1. Presentation is engaging, interesting and	4.7	Very Good

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understandable.		
2. I did not experience any technical issues while using the learning material.	4.27	Very Good
3. The learning material is easy to navigate and use.	4.76	Very Good
4. The learning material' design and colors make learning enjoyable.	4.73	Very Good
5. Learning material arouses interest of target viewers.	4.62	Very Good
Average Mean	**4.62**	**Very Good**
Overall Mean	**4.39**	**Very Good**
Legend: Very Good ~ 4.21-5.0 Good ~ 3.41-4.20 Fair ~ 2.61-3.40 Poor ~ 1.81-2.60 Very Poor ~ 1.0-1.80		

The android-inquiry activities received highly positive feedback across all assessed areas, with an overall mean score of 4.39 (Very Good). The learning material stood out for its Clarity, scoring a weighted mean of 4.21, highlighting the effectiveness of its instructions, artistic design, sentence length, and writing style. Regarding Relevance, the activities earned a weighted mean of 4.34, indicating that the interactive content fosters the development of advanced cognitive skills such as critical thinking, creativity, hands-on learning, and inquiry. The Engagement score was particularly high, at 4.62, reflecting that the material is engaging, interesting, easy to navigate, and capable of capturing the attention of its intended audience. In conclusion, the developed interactive learning material proves to be an effective educational tool, allowing students to explore a wide range of environments, objects, and phenomena that would typically be inaccessible, all within the classroom. It offers real-time opportunities for students to observe and interact with variables and processes in an immersive way.

4. CONCLUSION AND RECOMMENDATION

As evident by the moderate normalized gain score of 0.52, the developed Android-based inquiry activities on Gas Laws of Grade 10 STEM students was found very useful in improving the student-respondents attainment from "did not meet expectations" to a "very satisfactory" level. The "satisfactory" rating from the content and ICT experts-evaluators and the "very useful" rating of student-respondents corroborates the positive influence of the interactive learning material on the achievement level of the student respondents for the topic Gas Law in coverage of grade 10 STEM learners. Therefore, this shows that the Android-based inquiry activities had a positive impact on the student-respondent's understanding of the subject matter. Apropos of lesson improvement plan, the result of this study is functional as a bases for improved teaching-learning strategy.

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