# GAS TOOLKIT

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**ABSTRACT**

Mastery of chemistry concepts involves the ability to understand chemistry at all three levels; macroscopic, symbolic and submicroscopic levels. Inability to visualise the submicroscopic level (particle world) is a major problem for many chemistry students. Gas Toolkit is an education application for learning States of Matter: Gases. It enhances learning by engaging the sub-microscopic elements of the topic and making the learning experience more interactive. A usage study involving 99 students of the Matriculation Science Program was conducted. After an hour-long tutorial using the application, students achieved an average test score of 89.9% (SD 8.1%). Based on a Likert scale questionnaire 95% of the students are of the view that the Gas Toolkit has a positive impact on their learning of the topic. Similarly, the open-ended question finds out of 99 students, 90 gave positive feedbacks, 8 gave neutral or no feedback at all and only one negative feedback. Additional benefits of the toolkit are that it exposes students to various online chemistry resources and instil awareness on the utility of the digital ecosystem in the field of chemistry. In conclusion, the use of the application has successfully incorporated interactivity and sub-microscopic level learning of the topic and help improve students' learning of Properties of Gases.

**Keywords:** science education, chemistry, gas properties, educational application, and twenty-first-century learning.

## 1. INTRODUCTION

Mastery of concepts in chemistry involves the ability to understand the chemistry at all three (macroscopic, submicroscopic and symbolic) levels [1]. The macroscopic level refers to the chemistry that involves the five senses. The symbolic level refers to the chemistry that involves symbols, formulas, equations and pictorial notations. The submicroscopic level refers to the description of chemistry based on the particulate nature of matter. Discusses atoms, ions and molecules that are invisible to the naked eye. Inability to visualise the submicroscopic level is a major problem for many chemistry students. Thus, to understand gases student must be able to visualize how gas particles move and interact. To develop this ability interactive simulators have been proven to be beneficial [2]. Gas Tool Kit is an education application to be used by students for studying States of Matter: Gas, a topic in the matriculation chemistry curriculum. The tool kit allows students, teachers and users to make quicks references, engage interactive tools and simulators related to the study of Gas by using their mobile devices.

## 2. OBJECTIVES

This study aims to investigate the use of an application called Gas Toolkit to improve the learning of chemistry by incorporating elements of interactivity and sub-microscopic level learning. Objectives of this usage study are to:

i. Implement the Gas Toolkit as a learning tool in a classroom setting.

ii. Determine students' level of achievement after using the Gas Toolkit.
iii. Determine students' views on the usability of Gas Toolkit as a tool for learning States of Matter: Gases.

## 3. METHODS

The application layout of the Molecular Geometry Toolkit is shown in Figure 1.

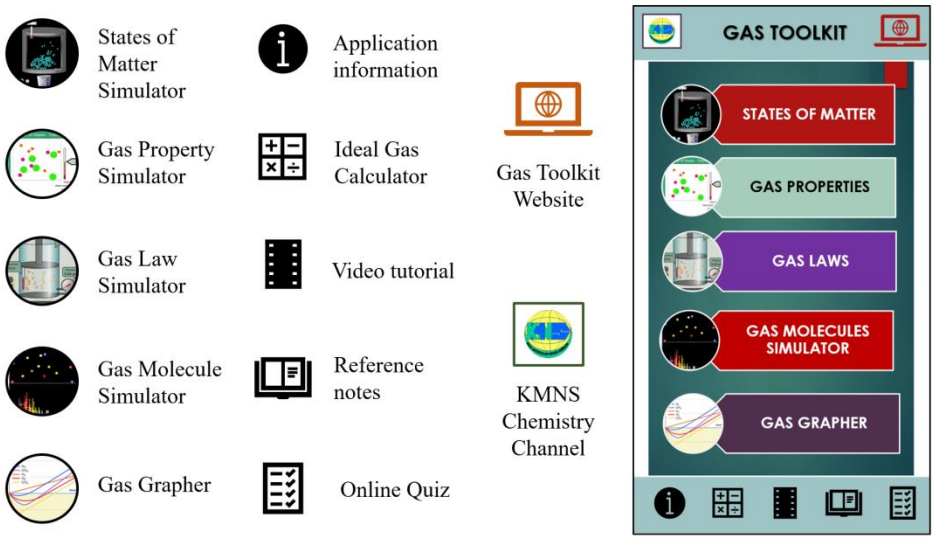


**Figure 1.** Application layout of the Molecular Geometry Toolkit

This usage study involved 99 students. A post-test is used to determine students' achievement level after using the application. It consists of 10 multiple choice questions carrying 10 marks. A usage questionnaire is used to gauge students' view on the usage of the application. The questionnaire comprises 10 four-point Likert scale questions and an open-ended question on students' view of the application.

## 4. RESULT AND DISCUSSION

The average post-test score is 89.9% (SD 8.1%). Out of 99 students, 95 got A (70% and above). The average time needed to complete assigned activities in Gas Toolkit is 40.7 minutes (SD 15.4 minutes). Previously the time allocated for the study of the topic is two hours.
Questionnaire feedback presented in Table 1 generally shows that the Gas Toolkit is well received by the students. More than 90 % of students agree that the use of the application brings numerous positive effects.

Table 1. Summary of Likert Scale Questionnaire

| | Strongly disagree | Disagree | Agree | Strongly disagree | % Agree |
|---|---|---|---|---|---|
| 1. I enjoy using GT to learn Behavior of Gas. | 0% | 3% | 34% | 63% | **97%** |
| 2. GT makes understanding the concept of the topic is easier. | 0% | 3% | 37% | 60% | **97%** |
| 3. GT is easy to use. | 0% | 4% | 39% | 57% | **96%** |
| 4. GT makes visualizing the movement of gas molecules easier. | 0% | 1% | 31% | 68% | **99%** |
| 5. GT increases my interest in the topic. | 0% | 5% | 40% | 55% | **95%** |

| | | | | | |
|---|---|---|---|---|---|
| 6. The use of animation to show the movement of gas molecules help me understand the topic. | 0% | 2% | 31% | 67% | **98%** |
| 7. Interactive learning of GT helps me understand the topic. | 0% | 3% | 39% | 58% | **97%** |
| 8. GT makes learning chemistry more interesting. | 0% | 2% | 33% | 65% | **98%** |
| 9. GT is suitable as a self-study tool. | 0% | 2% | 31% | 67% | **98%** |
| 10. GT helps me understand the topic faster. | 0% | 2% | 38% | 60% | **98%** |

Students responses to the open-ended question were very good. Out of 99 students 90 gave positive feedbacks, 8 gave neutral or no feedback at all and one gave negative feedback. Example of the comments are shown below:

*"With this Behaviour of Gas Simulator, I understand the topic without referring to my notes. I can also go deeper into the topic compared to just reading notes."*
*"Make me feel that learning is fun and easier to imagine those molecules of gases"*
*"The best simulator ever. Easy to understand (the topic). I don't have to go through the trouble of imagining in my mind how the molecules move. Hope it is used for other topics"*

## 5. CONCLUSION

The objective of the project to improve the learning of Gas Properties and make it more interesting and easier to learn has been achieved using the Gas Toolkit. Likewise, the problems of being able to visualise the movement of the gas particles and associate it with gas properties have been overcome. All this is done at virtually no cost since all the applications that packaged into the toolkit come from non-profit websites. In conclusion, the Gas Toolkit is an effective learning tool and its use should be made more widespread.

## REFERENCES


1. Mahaffy, P. (2004). The Future Shape of Chemistry Education. Chemistry Education: Research and Practice, 5 (3), 229-245.
2. Correia, A. P., Koehler, N., Thompson, A. & Phye, G. (2018): The application of PhET simulation to teach gas behaviour on the submicroscopic level: secondary school students' perceptions, Research in Science & Technological Education. DOI:10.1080/02635143.2018.1487834

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