Building Scientific Literacy Among Thai Youth

An Interactive Qualifying Project and Interactive Science and Social Project

Sponsored by

The Principia

Submitted by

Passavit Apinanthawachpong, Macy Antonette D. Castillo, Adhicha Chalermchuang, Aman Hiregoudar, Amrit Kaur, Nicholas Kirby, Steven Oliner, Ranvir Sirikogar

Submitted to

Asst. Prof. M.L. Siripastr Jayanta

Asst. Prof. Dr. Numpon Insin

Asst. Prof. Dr. Supawan Tantayanon

Mr. Patompong Leksomboon

Prof. Ulrike Brisson

Prof. Kim Hollan

Submitted

10 March 2024

Abstract

This report addresses The Principia's desire to increase scientific literacy among Thai youth. The Principia is a science media organization that holds interactive workshops with a key objective to engage with Thai youth. Our goals of identifying current science interests and creating a sustainability plan for The Principia were accomplished through surveys, lab observations, and hands-on activities utilizing inquiry-based learning. We concluded with recommendations for The Principia regarding our solution to improving scientific literacy among Thai youth.

Acknowledgements

The success of our project was significantly influenced by the support and assistance of many individuals. We would like to recognize and thank all of those who have helped us over the last few months.

First, we would like to thank our sponsor, The Principia, for supervising and guiding our project. Specifically, we had the opportunity to learn from Mr.Watchurin Unwet, Mr. Pichayut Tonanchayakul and Mr.Tanakrit Srivilas. A special thank you to Mr.Watchurin Unwet**,** as he took us under his wing to teach us invaluable information. While providing us a helping hand, our sponsors allowed us to take initiative and steer the project in whichever direction was needed to achieve our goals. Taking time out of their busy schedules, we found ourselves learning something new at every meeting, creating new perspectives on the current issue at hand, whether it be about presentation format, event logistics or scientific concepts. The lessons learned through our sponsor's guidance can be applied outside of our project, and that we will forever cherish.

We would also like to thank the community members at Chulalongkorn University and volunteers who aided us every step of the way while we determined the logistics of our project. From setting up table sittings at different university events, to helping us prepare for our own event, we were always supported. Furthermore, we truly appreciated all the help we received from our other Thai classmates when it came to translations. Working with upper secondary students, we found ourselves working in the Thai language constantly. With their help catching the attention of students and their knowledge of the school system, we were able to make major strides in our project.

We would also like to thank those who helped us with hosting our event: Kittiphan (Boy) Srichantamit for volunteering his help during the lab portion of our event and Professors Charoenkwan Kraiya and Somsak Pianwanit for judging the presentations as well as aiding in any uncertainty while experimenting with the keychains. Kittiphan being an ex-chemistry student himself, his knowledge of electrochemistry and lab safety was exceptionally displayed during the lab portion of our event. We would also like to thank Professor Prompong Pienpinijtham for providing guidance and helping to generate ideas in the pre-event phase.

Lastly, we would like to thank all the advisors associated with making our project a success. From Worcester Polytechnic Institute, we would like to recognize Kim Hollan and Ulrike Brisson for their unwavering guidance for the duration of the project. We would also like to thank Professor Joseph Dorion for preparing us to combat a social science issue. Their collective comments were very helpful in teaching us how to tackle our project in the most efficient manner. To continue, Aacaan Sumalee was extremely helpful as we prepared to travel to Thailand; teaching us the language as well as introducing us to the culture. This project could not have been possible without the help of the BSAC advisors who armed us with a variety of resources and aid throughout this project so a major thank you to Numpon Insin, Patompong Leksomboon, Siripastr Jayanta, and Supawan Tantayonan.

Key Terms & Definitions

Scientific Literacy – The language required to fully comprehend and further investigate scientific concepts utilizing critical thinking skills.

Scientific Communication – The language or presentation method required to engage and influence a diverse group of people regarding scientific concepts.

Target Demographic - Upper secondary level students (grades 10-12) in Thailand.

Macroscopic Level of Representation – This level refers to the phenomena that can be observed by the human eye.

Submicroscopic Level of Representation - The submicroscopic level dives deeper into why the phenomena is happening in a certain way, explaining processes that cannot be observed by the human eye.

Symbolic Level of Representation – The symbolic level uses chemical equations and other scientific terms to explain the processes in terms of science.

Research Question

How can we assist The Principia in building scientific literacy among Thai youth?

Executive Summary

Scientific literacy is one attribute of a society that can determine how technologically advanced a country can be (Espinosa, 2005). Currently in Thailand, the general public view science as a means to an end (Chen et al., 2019a). The Principia is a science media organization located in Thailand, whose motto is to improve society through science communication. Established in 2021, they cover a wide variety of scientific topics shared through podcasts, science communication events, social media as well as their website. Through this project, we aimed to identify the current interest in science, and create a project sustainability plan for The Principia, to continue expanding their outreach to upper secondary students.

Methodology

In order to assist the Principia in building scientific literacy among Thai youth, first we collected data to understand students' current interest in science. Then using that data, we identified and developed key Inquiry and Project Based Learning principles. Utilizing those principles, we designed and hosted an interactive science event to engage youth and increase science interest. Finally, we created a sustainability plan for The Principia so they could continue building scientific literacy among Thai Youth

To measure the current scientific interest among Thai youth, we conducted pre-surveys and organized an interactive event. By taking into account students' preferred learning style as well as previous research, we developed learning principles that we implemented into our interactive event in order to engage youth and increase their interest in science. We then collected data in order to measure the effectiveness of different aspects of our event that we utilized to create a sustainability plan for The Principia.

During our fieldwork, we encountered a number of challenges and limitations. The most impactful challenge was the language barrier. Our team's BSAC members bridged the gap as they translated survey responses and gained attraction from the high school students at the pre-survey events, as well as at our own event. The next challenge we faced was general scheduling. Our original plan was to host our event during the second week of February, but due to holidays and other scheduling conflicts we had to push it to the 17th. When changing the date of the event, it created slight issues with re-booking rooms on campus as well as revising the supplementary material to match the finalized event details.

Findings

Through evaluation of our observations as well as our pre and post survey responses, we developed the following findings regarding social media usage, science interest, learning principles and event outcomes:

1. **Publishing content on Instagram will reach upper secondary students**

   Instagram is the most popular social media platform among upper secondary students. Therefore, since students spend the most amount of time on this platform, publishing palatable and shareable content through Instagram will reach broader audiences.

2. **Hands-on activities that are fun and relatable increase interest in science**

   In order to increase interest in science, students should find it relatable, fun, engaging, and hands on. We discovered that the survey participants' interests stem from science being fun, their passion for discovering the world around us, as well as the possibilities of human and technological advancement.

3. **Inquiry based learning is an effective method for students to learn**

To understand how to effectively teach students, we observed two different labs, in Thai, during Chem See You Camp and Chula Open House that directly worked with secondary students. During these labs we found the students engaged and excited to learn. When speaking to the facilitators at these lab sessions, we also discovered that these attributes align with inquiry based learning principles.

4. **Upper secondary students prefer visual and kinesthetic learning**

   While we were initially gathering data to measure the current science interest among youth, we found that the survey participants were visual learners. After hosting the event, we found that the students who attended and had known about the experiment, were visual and kinesthetic learners. Therefore, a majority of students enjoyed the practical aspect of the event and when asked what we could improve about the event, had mentioned more hands-on activities in the lab.

5. **Students find electrochemistry more unique than surface tension**

   When organizing the event, we initially planned to host two activities so students would be able to experiment with different concepts. While conducting the registration for the event, students were asked what concept they would prefer experimenting with. It was found that a majority of students chose the electrochemistry experiment over the experiment relating to surface tension.

6. **Increased usage of keywords indicate higher levels of scientific literacy**

   During our pitch presentation section of the event, students created product ideas that related to electrochemistry and were presented to a panel of judges. The rubric was categorized into clarity, content, organization and presentation. We found that students

who scored higher had mentioned the highlighted keywords in their presentation while describing their product and its relation to electrochemistry.

7. **Enthusiastic hosts and comfortable environments positively influence student engagement while learning**

   A majority of students found that the enthusiasm and passion each host had, added to the knowledge the students had grasped.

8. **Collaboration creates opportunities to develop critical thinking skills**

   Students greatly enjoyed the opportunity to network and collaborate with other students.

We would like to take a moment to address that this study is not absolute. Our limited time and experience in education and scientific literacy decreases the reliability of this study. We had minimal experience in evaluating educational strategies as well as a variety of strengths and weaknesses in various aspects of hosting our event. The language barrier was the most impactful obstacle within our study. Although our team's Thai members were able to translate for us, the communication gap between both sides made it difficult to be as effective in our efforts to gather data. Readers should be aware of the various limitations in order to gauge the credibility of the report.

Recommendations

Based on our findings, we have created recommendations to assist The Principia in building scientific literacy among Thai youth. These recommendations are only a few practical suggestions that can initiate the improvement of scientific literacy in this age group.

1. **Engage with students through Instagram**

We recommend that The Principia focus on increasing their presence and creating more engaging content to better attract students. Additionally, when students enjoy their experience at

an event, they will share through Instagram, which will increase social media engagement and attract new followers.

2. Increase scientific literacy through a handful of strategies.

Based on the results from our event, survey responses, and prior research we concluded that it takes several strategies to best increase scientific literacy. We recommend that The Principia focus on implementing these strategies in their events to achieve optimal results.

- Present information in engaging methods
- Implement Inquiry and Project Based Learning
- Perform interactive activities
- Utilize unique concepts
- Create a low pressure environment

3. Form a partnership

We recommend the Principia to partner up with an organization that has easy access to chemicals and labs to conveniently make this kind of event available in the future. The findings and data collected from this event could be used to propose a partnership, for example, with the BSAC department at Chulalongkorn University that would be mutually beneficial to both parties.

These suggestions, if implemented, could potentially build scientific literacy. Furthermore, we hope that our research can apply to those beyond The Principia in Thailand, such as educators, students or more who are interested in building scientific literacy among any population. This research has the potential of demonstrating one of the various manners in which societies can thrive through building scientific literacy.

บทสรุปโครงการ

ความฉลาดรู้ด้านวิทยาศาสตร์เป็นคุณสมบัติหนึ่งของสังคมที่สามารถบ่งบอกได้ว่าประเทศนั้นจะมีความก้าวหน้าทางเทคโนโลยีได้มากแค่ไหน (Espinosa, 2005) โดยในปัจจุบันในประเทศไทย คนทั่วไปมองว่าวิทยาศาสตร์เป็นเครื่องมือเพื่อประสบความสำเร็จ (Chen et al., 2019a) The Principia คือองค์กรสื่อวิทยาศาสตร์ที่ก่อตั้งอยู่ในประเทศไทยเมื่อปี 2021 มีเป้าหมายที่จะพัฒนาสังคมผ่านการสื่อสารทางวิทยาศาสตร์โดยมีเนื้อหาที่หลากหลายและครอบคลุมหัวข้อทางวิทยาศาสตร์ ซึ่งถ่ายทอดผ่านพอดแคสต์ กิจกรรมการสื่อสารทางวิทยาศาสตร์ โซเชียลมีเดีย และเว็บไซต์ขององค์กร คณะผู้วิจัยมีเป้าหมายที่จะวัดความสนใจในวิทยาศาสตร์ และสร้างแผนโครงการความยั่งยืนสำหรับ The Principia เพื่อช่วยให้องค์กรเข้าถึงนักเรียนระดับมัธยมศึกษาตอนปลายได้อย่างต่อเนื่อง

วิธีดำเนินการวิจัย

ในการช่วย The Principia เพิ่มความฉลาดรู้ด้านวิทยาศาสตร์ให้กับเยาวชนไทย คณะผู้วิจัยได้รวบรวมข้อมูลเพื่อวัดความสนใจด้านวิทยาศาสตร์ของนักเรียนในปัจจุบัน จากนั้นคณะผู้วิจัยนำข้อมูลนั้นไปใช้ในการออกแบบกิจกรรม คณะผู้วิจัยได้นำหลักการการเรียนรู้แบบสืบสอบและการเรียนรู้โดยใช้โครงงานเป็นฐานมาใช้ในการออกแบบกิจกรรมด้วย คณะผู้วิจัยจะจัดกิจกรรมวิทยาศาสตร์ที่มีปฏิสัมพันธ์ โดยกิจกรรมนี้จะให้เยาวชนมีส่วนร่วมในวิทยาศาสตร์มากขึ้นและเพิ่มความสนใจด้านวิทยาศาสตร์ด้วย จากนั้นคณะผู้วิจัยนำข้อมูลทั้งหมดไปจัดทำแผนโครงการความยั่งยืนสำหรับ The Principia เพื่อให้องค์กรสามารถสานต่อความรู้ทางวิทยาศาสตร์ให้เยาวชนไทยได้อย่างต่อเนื่อง

คณะผู้วิจัยได้ทำการสำรวจกิจกรรมต่าง ๆ ที่จัดโดยคณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย และจัดกิจกรรมที่มีปฏิสัมพันธ์เพื่อวัดความสนใจทางวิทยาศาสตร์ในปัจจุบันของเยาวชนไทย คณะผู้วิจัยนำข้อมูลจากการสำรวจ รวมถึงรูปแบบการเรียนรู้ที่นักเรียนชอบ ไปพัฒนาหลักการเรียนรู้ที่นำไปใช้ในการจัดกิจกรรม การจัดกิจกรรมนี้มีจุดประสงค์ให้เยาวชนไทยมีโอกาสเข้าร่วมในกิจกรรมทางวิทยาศาสตร์และเพิ่มความสนใจ

ในวิทยาศาสตร์ จากนั้นคณะผู้วิจัยทำการสำรวจเพื่อวัดประสิทธิผลของกิจกรรมและคณะผู้วิจัยใช้ข้อมูลนั้นเพื่อสร้างแผนโครงการความยั่งยืนสำหรับ The Principia

ในระหว่างการสำรวจและช่วงที่จัดกิจกรรม คณะผู้วิจัยพบกับความท้าทายและข้อจำกัดหลายประการ ความท้าทายที่มีผลกระทบมากที่สุดคืออุปสรรคทางภาษา สมาชิก BSAC ในกลุ่มช่วยแก้ปัญหานี้โดยการแปลคำตอบจากการสำรวจ ช่วยดึงดูดความสนใจจากนักเรียนมัธยมปลายในช่วงการสำรวจและพูดคุยกับนักเรียนในงานกิจกรรมด้วย ข้อจำกัดต่อไปคือการกำหนดวันที่จะจัดกิจกรรม คณะผู้วิจัยวางแผนที่จะจัดกิจกรรมในช่วงสัปดาห์ที่สองของเดือนกุมภาพันธ์ แต่เนื่องจากช่วงนั้นมีวันหยุดและมีการขัดแย้งอื่น ๆ คณะผู้วิจัยจึงต้องเลื่อนไปเป็นวันที่ 17 การเปลี่ยนวันที่จะจัดกิจกรรม ทำให้เกิดปัญหากับการจองสถานที่ และคณะผู้วิจัยต้องปรับเปลี่ยนเนื้อหากิจกรรมให้ตรงกับความต้องการของนักเรียนที่ลงทะเบียนด้วย

ผลการวิจัย

จากการสรุปผลข้อมูลจากการสำรวจกิจกรรมต่าง ๆ ที่จัดโดยคณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย และแบบสำรวจก่อนและหลังกิจกรรมที่คณะผู้วิจัยจัด คณะผู้วิจัยได้พัฒนาข้อค้นพบเกี่ยวกับการใช้สื่อโซเชียลมีเดีย ความสนใจด้านวิทยาศาสตร์ หลักการเรียนรู้ และผลลัพธ์ของกิจกรรม ดังนี้:

1. ***เนื้อหาบน Instagram สามารถเข้าถึงนักเรียนระดับมัธยมศึกษาตอนปลายได้ดี***

   Instagram เป็นแพลตฟอร์มโซเชียลมีเดียที่ได้รับความนิยมมากที่สุดในหมู่นักเรียนระดับมัธยมศึกษาตอนปลาย ดังนั้น เนื่องจากนักเรียนใช้เวลาส่วนใหญ่บนแพลตฟอร์มนี้ การเผยแพร่เนื้อหาผ่านทาง Instagram จะทำให้เข้าถึงนักเรียนระดับมัธยมศึกษาตอนปลายได้มากขึ้น

2. ***กิจกรรมเชิงปฏิบัติที่สนุกสนานและเชื่อมโยงได้กับชีวิตจริงจะช่วยเพิ่มความสนใจทางด้านวิทยาศาสตร์***

   เพื่อเพิ่มความสนใจทางด้านวิทยาศาสตร์ เนื้อหาควรสามารถถูกเชื่อมโยงเข้ากับชีวิตจริงได้ มีความสนุกสนาน มีความน่าดึงดูด และสามารถลงมือปฏิบัติได้จริง คณะผู้วิจัยค้นพบว่าความสนใจทางด้าน

วิทยาศาสตร์ของผู้ตอบแบบสอบถามนั้นเกิดจากความสนุกสนานของวิทยาศาสตร์ ความหลงใหลในการสำรวจโลกรอบตัว ตลอดจนความเจริญก้าวหน้าทางด้านเทคโนโลยี

3. ***การเรียนรู้แบบสืบสอบเป็นวิธีการเรียนรู้ที่มีประสิทธิภาพ***

เพื่อทำความเข้าใจวิธีการสอนนักเรียนอย่างมีประสิทธิภาพ คณะผู้วิจัยได้ทำการสังเกตการณ์ห้องปฏิบัติการในกิจกรรม Chem See You Camp และ Chula Open House ซึ่งในกิจกรรมเหล่านี้ ผู้สอนได้มีปฏิสัมพันธ์โดยตรงกับนักเรียนชั้นมัธยมศึกษา คณะผู้วิจัยค้นพบว่าผู้เรียนมีความสนใจและตื่นเต้นที่จะเรียนรู้ เมื่อคณะผู้วิจัยได้พูดคุยกับผู้สอน คณะผู้วิจัยได้ค้นพบว่าคุณลักษณะในการสอนเหล่านี้สอดคล้องกับหลักการเรียนรู้แบบสืบสอบ

4. ***นักเรียนระดับมัธยมศึกษาตอนปลายชื่นชอบการเรียนรู้โดยการใช้สายตาและการเรียนรู้โดยการปฏิบัติ***

ขณะที่คณะผู้วิจัยรวบรวมข้อมูลเพื่อวัดความสนใจทางด้านวิทยาศาสตร์ในหมู่เยาวชน คณะผู้วิจัยได้ค้นพบว่าผู้เข้าร่วมการสำรวจเป็นผู้เรียนรู้โดยการใช้สายตา ภายหลังจากกิจกรรม คณะผู้วิจัยค้นพบว่านักเรียนที่เข้าร่วมกิจกรรมและมีความรู้เกี่ยวกับการทดลองเป็นผู้เรียนรู้โดยการใช้สายตาและการปฏิบัติ ดังนั้น นักเรียนส่วนใหญ่จึงเพลิดเพลินกับกิจกรรมเชิงปฏิบัติ และเมื่อถูกถามว่าคณะผู้วิจัยสามารถปรับปรุงอะไรเกี่ยวกับกิจกรรมนี้ได้ ผู้เข้าร่วมกิจกรรมได้กล่าวถึงการมีกิจกรรมเชิงปฏิบัติมากขึ้น

5. ***นักเรียนมองว่าเนื้อหาเรื่องเคมีไฟฟ้ามีความน่าสนใจกว่าเรื่องแรงตึงผิว***

ระหว่างการเตรียมจัดกิจกรรม คณะผู้วิจัยวางแผนจะจัดทำการทดลอง 2 การทดลองเพื่อให้ผู้เข้าร่วมกิจกรรมได้เลือกทำการทดลองที่แตกต่างกัน ซึ่งในช่วงลงทะเบียนเข้าร่วมกิจกรรม คณะผู้วิจัยพบว่าผู้เข้าร่วมส่วนใหญ่เลือกทำการทดลองเคมีไฟฟ้า

6. ***การใช้คีย์เวิร์ดที่มากขึ้นบ่งบอกถึงระดับความฉลาดรู้ด้านวิทยาศาสตร์ที่สูงขึ้น***

ในช่วงการนำเสนอผลงาน นักเรียนได้สร้างสรรค์แนวคิดเกี่ยวกับผลิตภัณฑ์ที่เกี่ยวข้องกับเคมีไฟฟ้าและนำเสนอต่อคณะกรรมการ เกณฑ์การให้คะแนนแบ่งออกเป็นด้านเนื้อหา ความชัดเจน การนำ

เสนอ และการจัดลำดับเนื้อหา คณะผู้วิจัยค้นพบว่ากลุ่มนักเรียนที่ทำคะแนนได้สูงกว่ามีการนำคีย์เวิร์ดมาใช้ในการนำเสนอในระหว่างที่อธิบายผลิตภัณฑ์และความสัมพันธ์กับเคมีไฟฟ้า

7. ***ผู้นำกิจกรรมที่มีความกระตือรือร้นและสภาพแวดล้อมที่ดีส่งผลเชิงบวกต่อการมีส่วนร่วมของนักเรียน***

   นักเรียนส่วนใหญ่พบว่าความกระตือรือร้นของผู้นำกิจกรรม มีส่วนช่วยให้นักเรียนเข้าใจในเนื้อหามากยิ่งขึ้น

8. ***การทำงานร่วมกับผู้อื่นสร้างโอกาสในการพัฒนาทักษะการคิดเชิงวิพากษ์***

   นักเรียนเพลิดเพลินที่ได้รับโอกาสในการสร้างเครือข่ายและทำงานร่วมกับนักเรียนคนอื่น ๆ

คณะผู้วิจัยมีความตระหนักรู้ว่าการศึกษาวิจัยนี้ยังไม่สมบูรณ์ เวลาและประสบการณ์ที่จำกัดของคณะผู้วิจัยในด้านการศึกษาและความฉลาดรู้ด้านวิทยาศาสตร์ทำให้ความน่าเชื่อถือของการศึกษาวิจัยนี้ลดลง คณะผู้วิจัยมีประสบการณ์เพียงเล็กน้อยในการประเมินกลยุทธ์ด้านการศึกษา ตลอดจนจุดแข็งและจุดอ่อนในด้านต่าง ๆ ของการจัดกิจกรรม อุปสรรคด้านภาษาเป็นอุปสรรคที่มีผลกระทบมากที่สุดในการศึกษาวิจัยครั้งนี้ แม้ว่าสมาชิกชาวไทยในกลุ่มของคณะผู้วิจัยจะสามารถแปลภาษาได้ แต่ช่องว่างในการสื่อสารระหว่างทั้งสองฝ่ายทำให้การรวบรวมข้อมูลอย่างมีประสิทธิภาพเป็นไปได้ยาก ผู้อ่านควรตระหนักถึงข้อจำกัดต่าง ๆ เพื่อประเมินความน่าเชื่อถือของรายงาน

คำแนะนำ

จากผลการวิจัย คณะผู้วิจัยได้จัดทำคำแนะนำเพื่อส่งเสริม The Principia ในการสร้างความฉลาดรู้ด้านวิทยาศาสตร์ในหมู่เยาวชนไทย คำแนะนำเหล่านี้เป็นเพียงข้อเสนอแนะเชิงปฏิบัติเบื่องต้นที่สามารถนำมาใช้สำหรับการเริ่มต้นพัฒนาความฉลาดรู้ด้านวิทยาศาสตร์ในกลุ่มอายุนี้

1. ***มีส่วนร่วมกับนักเรียนผ่านทาง Instagram***

คณะผู้วิจัยแนะนำให้ The Principia มุ่งเน้นไปที่การเพิ่มการปรากฏตัวบนโซเชียลมีเดียและสร้างเนื้อหาที่น่าสนใจมากขึ้นเพื่อให้สามารถดึงดูดนักเรียนได้ดียิ่งขึ้น นอกจากนี้ เมื่อนักเรียนเพลิดเพลินกับ

ประสบการณ์ในกิจกรรม พวกเขาจะถ่ายทอดประสบการณ์เหล่านั้นลงบน Instagram ซึ่งสามารถเพิ่มการมีส่วนร่วมบนโซเชียลมีเดียและสามารถดึงดูดผู้ติดตามใหม่เข้ามาได้

2. เพิ่มความฉลาดรู้ด้านวิทยาศาสตร์ด้วยกลยุทธ์เหล่านี้

จากผลลัพธ์ของกิจกรรม การทำแบบสอบถาม และการวิจัยก่อนหน้านี้ คณะผู้วิจัยสามารถสรุปได้ว่ากลยุทธ์เหล่านี้สามารถช่วยพัฒนาความฉลาดรู้ด้านวิทยาศาสตร์ได้ดีที่สุด คณะผู้วิจัยขอแนะนำให้ The Principia มุ่งเน้นไปที่การใช้กลยุทธ์เหล่านี้ในกิจกรรมของตนเพื่อให้ได้ผลลัพธ์ที่ดีที่สุด

- นำเสนอข้อมูลในรูปแบบที่น่าสนใจ
- ใช้หลักการเรียนรู้แบบสืบสอบและหลักการเรียนรู้โดยใช้โครงงานเป็นฐานในการออกแบบกิจกรรม
- จัดกิจกรรมที่มีการโต้ตอบกัน
- ใช้หัวข้อที่มีเอกลักษณ์
- สร้างสภาพแวดล้อมที่มีความกดดันต่ำ

3. จัดตั้งพันธมิตร

คณะผู้วิจัยแนะนำให้ The Principia ร่วมมือกับองค์กรที่สามารถเข้าถึงสารเคมีและห้องปฏิบัติการได้ง่าย เพื่อให้องค์กรมีความสะดวกสบายหากมีการจัดกิจกรรมรูปแบบนี้ขึ้นอีกในอนาคต ผลการวิจัยและข้อมูลที่รวบรวมจากกิจกรรมในครั้งนี้สามารถนำไปใช้ในการเสนอการจัดตั้งพันธมิตรได้ เช่น การจัดตั้งพันธมิตรกับคณะวิทยาศาสตร์ สาขาเคมีประยุกต์ (BSAC) จุฬาลงกรณ์มหาวิทยาลัย ซึ่งการจัดตั้งพันธมิตรจะสามารถสร้างประโยชน์ให้กับทั้งสองฝ่าย

การนำคำแนะนำเหล่านี้ไปปฏิบัติ อาจมีส่วนช่วยในการเสริมสร้างความฉลาดรู้ด้านวิทยาศาสตร์ได้ นอกจากนี้ คณะผู้วิจัยหวังว่าการศึกษาวิจัยในครั้งนี้จะสามารถนำไปประยุกต์ใช้กับผู้อื่นนอกเหนือจาก The Principia ได้เช่นกัน เช่น นักการศึกษา นักเรียนนักศึกษา หรือผู้อื่นที่มีความสนใจเกี่ยวกับการสร้างความฉลาดรู้ทางวิทยาศาสตร์ งานศึกษาวิจัยนี้มีศักยภาพในการแสดงให้เห็นถึงหนึ่งในมุมมองที่ว่าสังคมจะสามารถพัฒนาและเติบโตขึ้นได้ผ่านการสร้างความฉลาดรู้ทางวิทยาศาสตร์

Authorship

Aman Hiregoudar - Robotics Engineering

Aman wrote parts of the methodology, results, conclusions, and recommendations chapter. While facilitating parts of communications between advisors and the group, he was also responsible for a majority of the logistics throughout the project, preparing the survey forms and troubleshooting the experiment. He developed the sustainability plan, edited several parts of the report, and was responsible for parts of the booklet. He also led the graphic design and organizational efforts of the group for our presentations, flyers, and certificates.

Amrit Kaur - Industrial Engineering

Amrit wrote parts of the abstract, acknowledgements, introduction, background, methodology, and results while leading discussion regarding next steps in terms of the project. She continuously ensured that the work was distributed among all while coordinating between advisor feedback and the group members. She was also responsible for facilitating the event and coordinating between all of the groups the day of the event while working on logistics throughout the project. She frequently found herself editing parts of the report as well as the data analysis and she was also responsible for parts of the booklet.

Nicholas Kirby - Mathematics

Nick wrote parts of background, results and executive summary. He also led the data analysis from all of our surveys and made graphs corresponding to it. He was responsible for writing information regarding the data that he analyzed from the surveys as well as data collected from The Principia's Instagram.

Steven Oliner - Computer Science

Steven wrote parts of the abstract, background and results. He also aided in data analysis. He was responsible for analyzing data from the surveys, and creating graphic design content for some supplemental materials.

Adhicha Chalermchuang - Applied Chemistry: Materials Chemistry

Adhicha wrote parts of the introduction and background chapter. She primarily worked on sections relating to science in Thailand and science communication. She also provided translations so that everyone can analyze the survey responses.

Macy Antonette D. Castillo - Applied Chemistry: Materials Chemistry

Macy wrote parts of the executive summary, introduction, background, and methodology chapter. She primarily worked on the sections involving scientific literacy, science in Thailand, and science communication. She was also responsible for communication between the group and the sponsor, gathering survey responses, conducting observations, preparing materials (manuals and slides) for the event, troubleshooting the experiment, coordinating between many different parties to prepare for the event, and facilitating the event we organized. She also played a part in the graphic design efforts of the group and was responsible for parts of the booklet.

Passavit Apinanthawachpong - Applied Chemistry: Industrial Chemistry and Management

Passavit wrote parts of the executive summary, introduction, and background chapter. He primarily worked on the sections relating to the benefits of improved scientific literacy. He was

also responsible for gathering survey responses, conducting observations, translating, troubleshooting the experiment, and facilitating the event we organized.

Ranvir Sirikogar - Applied Chemistry: Environmental Chemistry

Ranvir wrote parts of the background chapter and the executive summary. He primarily worked on the sections relating to the current efforts in building scientific literacy and encouraging youths to become science communicators. He was also responsible for gathering survey responses, consulting chemistry professors regarding the experiment and their content, coordinating with labs to prepare materials, troubleshooting the experiment, and facilitated volunteer communication regarding the event logistics.

Table of Contents

List of Figures

List of Tables

1. Introduction

Equipping a population with scientific literacy in order to tackle current and future challenges often improves a society in both technological and economical aspects, as adequate scientific literacy is a key ingredient of a successful and well-developed country. Modern life would not have been as convenient without science, yet society still lacks a sufficient level of scientific literacy or understanding of science (Espinosa, 2015). The ability of individuals to apply scientific knowledge helps them to make informed decisions, allowing them to analyze information critically, and evaluate the integrity of the information.

The practical application of scientific knowledge helps develop technological advancement and competition as well as drive economic growth on a global scale. Countries with high scientific literacy and relatively stable economies often develop innovative ecosystems, which attract investment and encourage entrepreneurship. For instance, Silicon Valley's success is deeply rooted in scientific and technological investments, which in turn, lead to advancements in various industries ultimately contributing to economic growth in the area (Morrison, 2023).

Although science is considered an important discipline in Thailand, public scientific literacy is still inadequate (Chen et al., 2019a). Thai youth are academically encouraged to study science, but the value of science outside of the classroom is not recognized by most of the public, since there are few scientific professionals. It is evident that Thai students have low scientific literacy, as the latest Programme for International Student Assessment (PISA) has Thailand ranked 58th for mathematics and science scores among 81 countries (Bangkok Post, 2023). The science score in PISA is meant to measure the level of scientific literacy of a 15-year-old in

applying scientific knowledge to identify questions, gain new knowledge, explain scientific phenomena, and conclude (OECD, 2023).

There are a few issues to be studied in order to thoroughly understand the problem of low public scientific literacy. The public's access to scientific content and information can be limited in terms of both quantity and quality (Chen et al., 2022). Up-to-date information is scarce and often perceived as uninteresting. In addition, the terminology of content is often too specific and difficult for the audience to completely understand. It is not easy for people without a scientific background to understand scientific content. This can discourage the public's interest in further pursuing science.

The sponsor of this project is The Principia, a media group made up of scientists, educators and academics, who has attempted to address this shortfall in scientific literacy by posting articles and short form content on their social media about recent science events. Additionally, they participate in and host larger science events, such as the Science Communication Festival in 2023. However, these efforts have not been enough due to the pause in gatherings during the COVID-19 pandemic, no previous opportunity to reach out to youth and The Principia not having access to feedback regarding prior initiatives. The Principia is looking for more innovative ways to engage students in science to promote lifelong learning. With our approach, not only do we have the opportunity to engage youth with science but we continuously assess our efforts to gather feedback from the students.

The goal of this project was to assist The Principia in improving scientific literacy among Thai youth in grades 10 through 12. First, we collected data to understand students' current interest in science. Then using that data, we identified and developed key Inquiry and Project

Based Learning principles. Using these principles, we designed and hosted an interactive science focused event to engage youth and increase interest in science. Our event had a total of 42 students that were split into two groups; each group experimented to come up with scientific concepts from their observations. Finally, based on the post-survey data we collected, and performance of our event, we created a sustainability plan for The Principia to share our recommendations for increasing youth interest in science through interactive workshops. Due to the time constraints of our project, we were only able to host one event but the recommendations from the research conducted through this interactive science workshop should continue to have a long term impact on students' scientific literacy and interest. Our project should positively influence upper secondary students by increasing their interest in science which should improve scientific literacy.

2. Background

Humans establish policy, create technology, develop curricula and manage budgets for organizations in which a system is in place and a group of people is either represented or impacted. The educational system universally is no different. This chapter discusses scientific literacy and communication, the education system in Thailand, current efforts to build scientific literacy, the perception of science education, and encouragement to improve the perception of science as well as The Principia's role in improving scientific literacy to increase people's understanding of and interest toward science.

2.1 - Scientific Literacy

Murcia (2006) illustrates scientific literacy as three interacting elements: scientific terms and concepts, the nature of science, the interaction of science with society. This can be illustrated as in Figure 1.

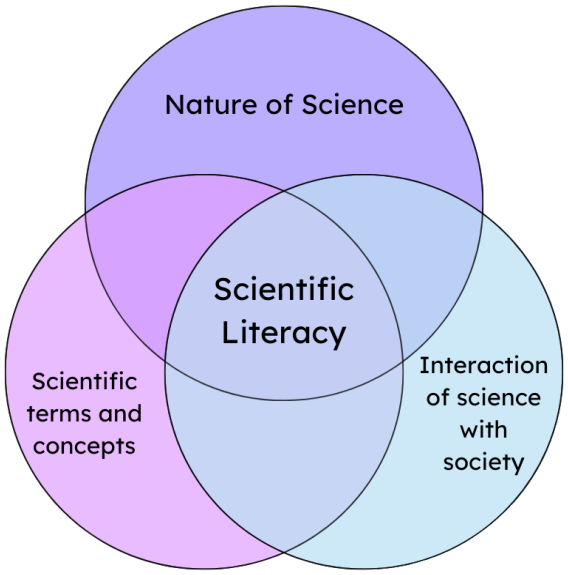


Figure 1: Interacting Elements of Scientific Literacy

Scientific terms and concepts are defined as the knowledge that is required to understand specific phenomena in our daily lives and will continue to be required for the next decade. This also includes knowledge and concepts that are required to participate in public decisions involving scientific developments.

Lederman and Zeidler (1987) define the nature of science as "the values and assumptions inherent to the development of scientific knowledge" (p. 3). The values mentioned by Lederman and Zeidler are the values from the Nature of Scientific Knowledge Scale (NSKS) by Peter A. Rubba (1976). NSKS uses six characteristics when defining scientific knowledge. These are listed in Table 1.

Table 1: NSKS Scientific Knowledge Characteristics

Amoral	the knowledge itself cannot be characterized as good or bad
Creative	the knowledge is a product of human intellect and creativity
Developmental	the knowledge is never fully proven as more research, experiments, and testing can always be done to further increase the validity of the knowledge or even disprove it
Parsimonious	the knowledge is explained as simply as possible/needed
Testable	the knowledge can be empirically tested
Unified	the knowledge also contributes to other disciplines

The third element of scientific literacy, the interaction of science with society, is the application and implementation of scientific knowledge in our daily lives and how it can affect society (Kolstø, 2001). Knowing how to apply scientific knowledge and its impact on society is also an important part of being scientifically literate.

2.2 - Science Communication and its Importance

The National Academies of Sciences, Engineering, and Medicine (NASEM, 2017) define science communication as exchanging scientific information to accomplish a predefined goal. The report identified five goals for communicating science, shown in Figure 2.

Figure 2: NASEM Goals for Science Communication

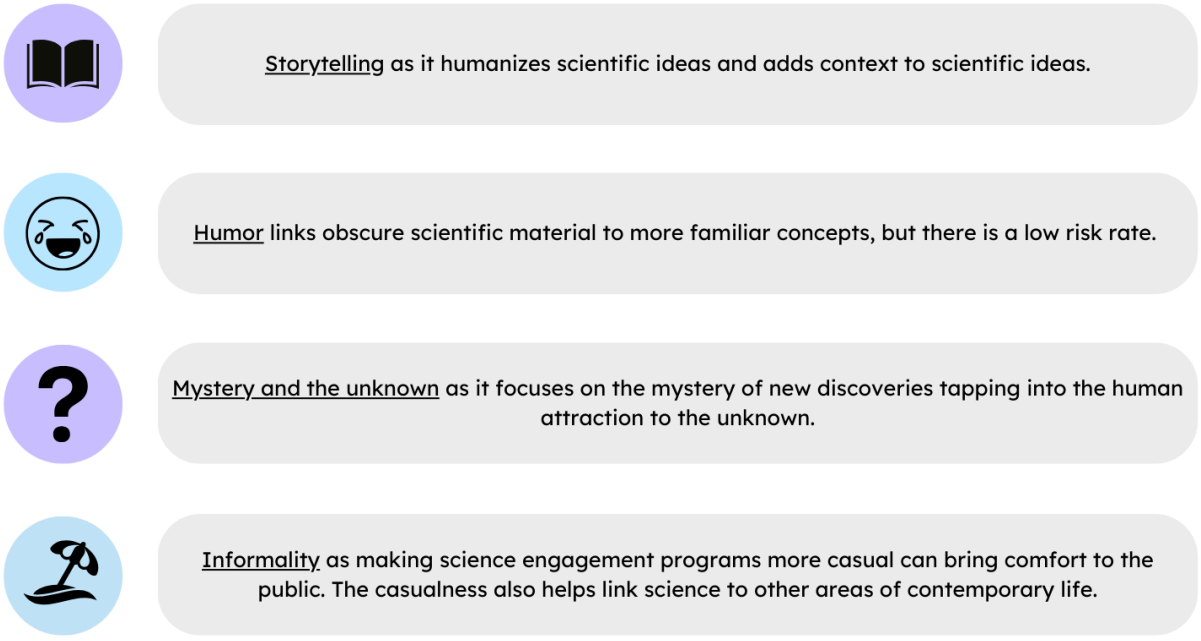
2.2.1 - The Importance of Science Communication

Jucan and Jucan (2014) argue that since public funds are used to support scientific work, scientists have an ethical obligation to produce intelligible and factual information, while declaring the value and social implications of their work. Scientists should also ensure the public's awareness regarding their work. Treise and Weigold (2002) discuss that effective science reporting may be the only way that people can learn about new developments and innovations. In this context, science communication informs the general public about what is happening in science news while providing greater context for scientific activities such as research and experimentation. Effective science communication also provides the public with information that is important when forming opinions about science-related public policies.

2.2.2 - Communicating Science Effectively

There are many factors that make effective science communication difficult. The NASEM (2017) mentions that the nature of scientific information itself makes science communication more challenging. While scientific knowledge is usually reliable as it is reproducible and peer-reviewed, scientific findings can also be incomplete, unclear, and their utility may not be outright obvious. As mentioned previously, scientific knowledge is developmental, so what is considered a fact today may be disproven in the future, causing doubt and skepticism in the public.

Science communication traditionally focuses on the transfer of information and its efficiency. While these two aspects are important to keep in mind, there is much more to effective science communication than transferring information efficiently. A report by Kaiser et al. (2014) introduces eight topics science communicators should keep in mind when reaching out to a wider audience, described in Figure 3.



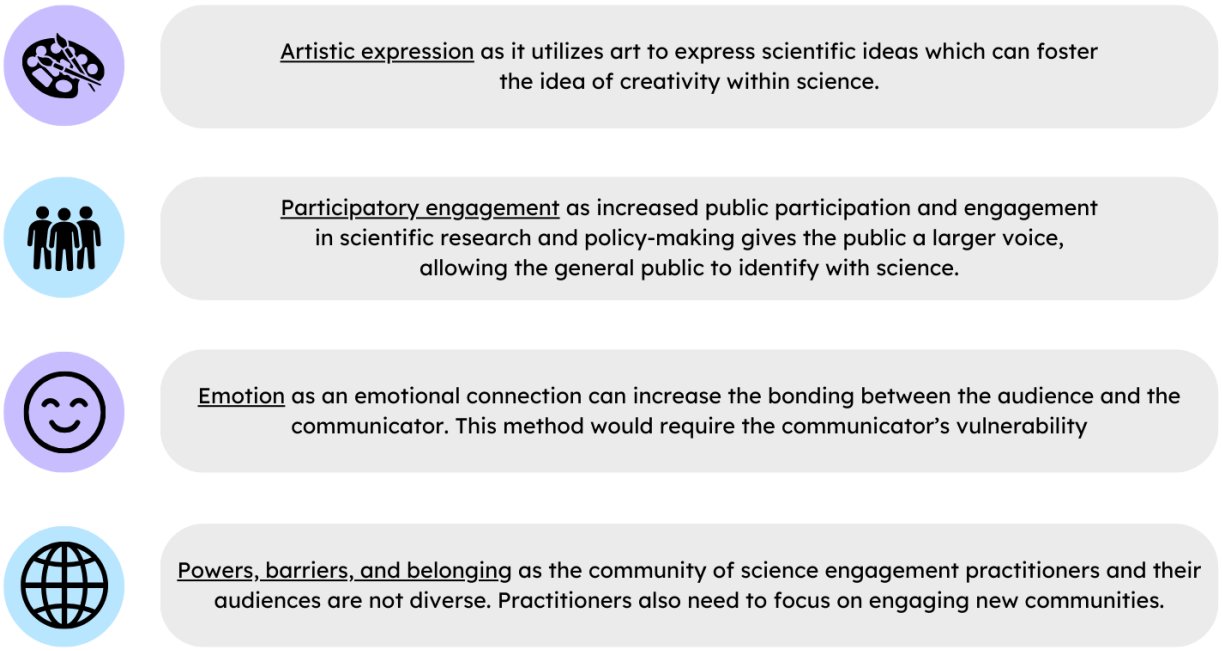


Figure 3: Key Topics for Science Communicators

2.3 - Careers in Science

When considering scientific literacy, it is important to have a large enough scope that encompasses all the careers that could involve scientific literacy. Scientific literacy includes having many different skills in the scientific field such as critical thinking and evidence-based reasoning. In Thailand, career data from the National Science Technology and Innovation Policy Offices shows that while the workforce totals about thirty-nine million, only about three million people work in the science and technology field (Koomtong, et al., 2014). Additionally, a majority of the three million people in the science and technology workforce only have an education up to junior high school. This lack of highly-educated people in the science workforce can be connected to science education in Thai high schools.

2.4 - Education in Thailand

The Ministry of Education in Thailand mandates nine years of basic education, also granting an optional preschool background starting at age three. Once a child turns six, they are enrolled into a primary educational institution usually with an academic calendar from June to March. Education in Thailand is divided into primary school (Grades 1-6), lower secondary (Grades 7-9), and upper secondary school (Grades 10-12) (Ministry of Education, 2008).

Not all upper secondary students have the same level of science education. At the upper secondary level, students must choose a study plan from five disciplines, shown below in Figure 4 (Plook TCAS, 2022).

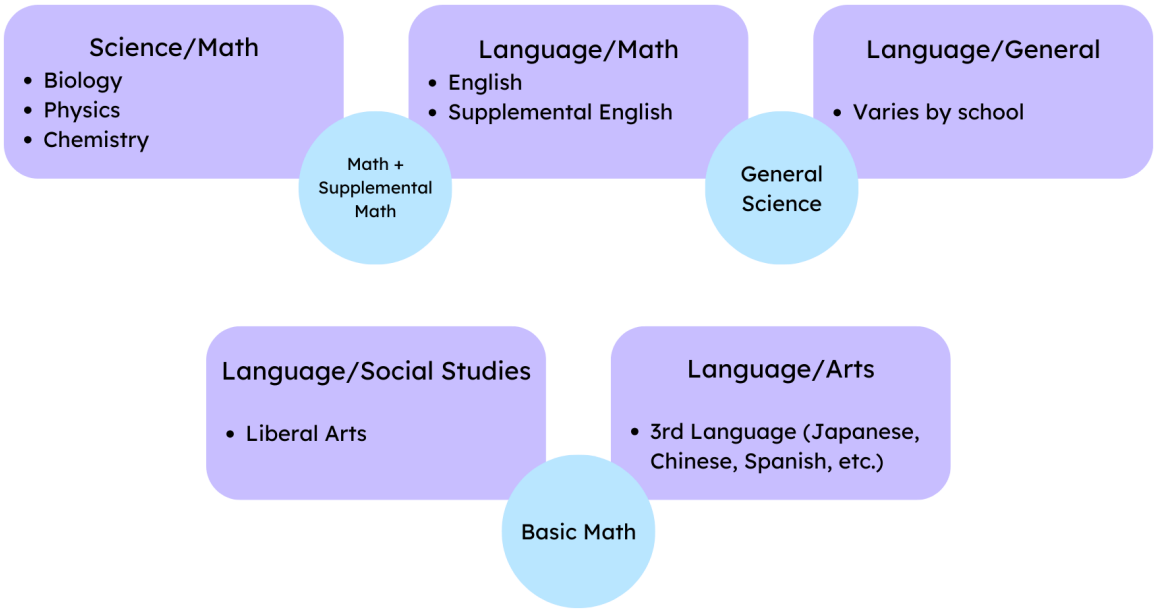


Figure 4: Possible Disciplines for Upper Secondary Students in Thailand

It is important to consider a student's study plan, as a student's interests and background are greatly influenced by this choice. Additionally, these concentrations affect a student's future path in university and a future career.

2.4.1 - Teaching Styles

There are different approaches to teaching, one that is teacher driven and the other that is inquiry based. The latter promotes inquiry, project and problem-based learning which highlights the scientific literacy approach that our team plans to build upon, while the other method focuses on memorization and assessment-driven learning. There are five phases in inquiry based learning outlines in Figure 5 (Pedaste, et al., 2015).

Figure 5: Phases of Inquiry Based Learning

The purpose of the phases is to encourage students to learn concepts through discovery and discussion. The Institute for the Promotion of Teaching Science and Technology aims to change teaching styles to leave lecture-based teaching behind and focus more on inquiry-based teaching. However, the push towards improving teacher training has not yet taken place. Furthermore, there is currently a gap between the policy makers for the curriculum and teachers when addressing what to teach and how to teach it (Kolstø, 2001).

One model of inquiry based learning uses Johnstone's Levels of Representation to describe the types of learning that helps students succeed (Wicaksono, 2022). They are primarily

used to describe chemistry-based lessons, but can be adapted to other concentrations. The three levels of representation are described in Figure 6.

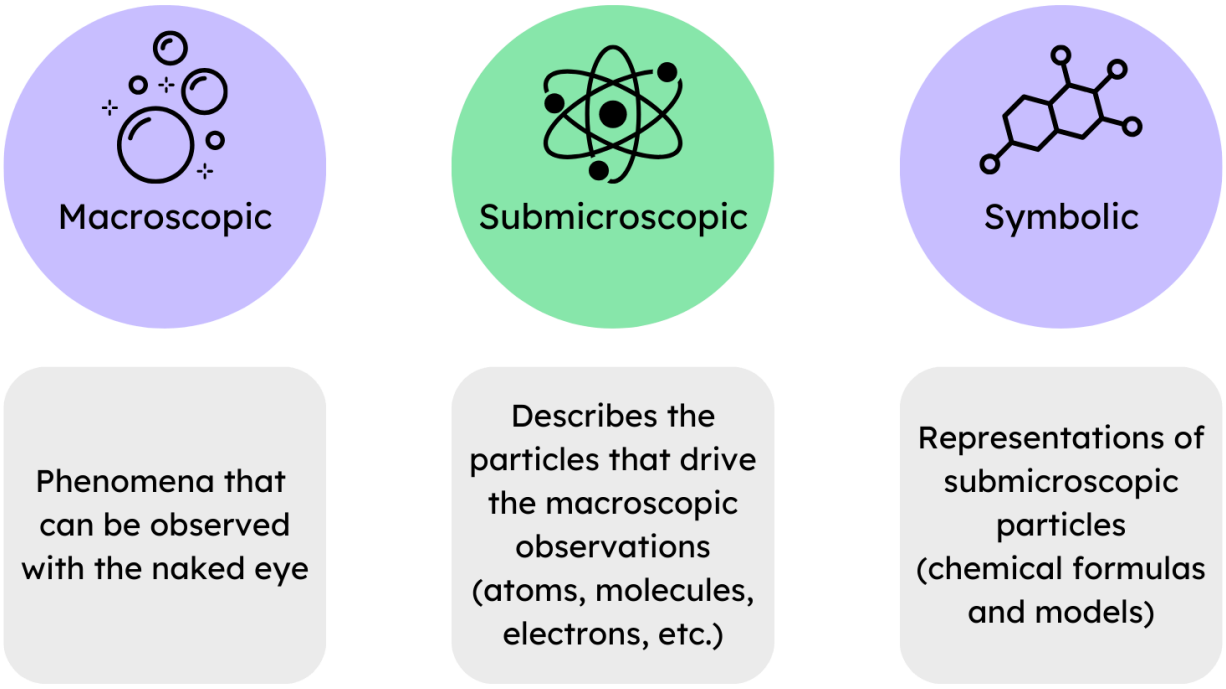


Figure 6: Johnstone's Three Levels of Representation

The use of all 3 levels of representation allows for a complete understanding of the topic, while engaging the student in an inquiry-based approach.

Another teaching style utilizes Project Based Learning (PBL) which is a "teaching method in which students learn by actively engaging in real-world and personally meaningful projects" (Buck Institute of Education, n.d.). PBL has multiple key concepts, displayed in Figure 7, that requires students to use critical thinking to produce a product or presentation.

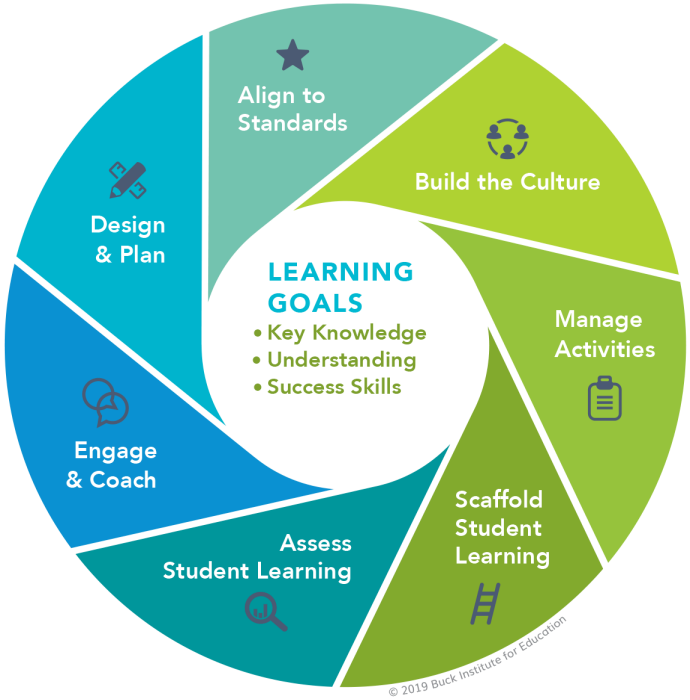


Figure 7: Project Based Learning Teaching Practices, Buck Institute of Education

In addition to great outcomes in the classroom, project based learning has been shown to significantly improve students' life long skills in problem solving, developing ideas, teamwork, and communication (Heinricher, et al., 2013).

2.5 - Perceptions and Challenges to Public Science Literacy in Thailand

Currently in Thailand, the public perception of science is poor (Chen et al., 2019a). Science is perceived simply as a means to an end; which is to pass the entrance exams for higher education. Also, there is poor communication of current scientific issues to the general public (Chen et al., 2022). As a result, Thai youths are unaware and unable to perceive the benefits of learning science. Many Thai people perceive science to be important, but feel that it is too

difficult, and/or do not have much interest. Therefore, the scientific literacy of the general public is not high. The major challenges to improve science literacy in Thailand described by Chen are outlined in Figure 8.

Figure 8: Challenges to Improving Scientific Literacy in Thailand

The result is that Thailand is ranked only fifty-eighth among eighty-one countries in the PISA which is considered below the global standard even though Thai students spend more hours in school than other countries in the world (Institute for the Promotion of Teaching Science and Technology [IPST], 2006, 2018)

2.5.1 - Barriers to Science Education

The Thai youths in the survey conducted by Chen et al. (2019b) saw that there are three main barriers to science education, outlined in Figure 9.

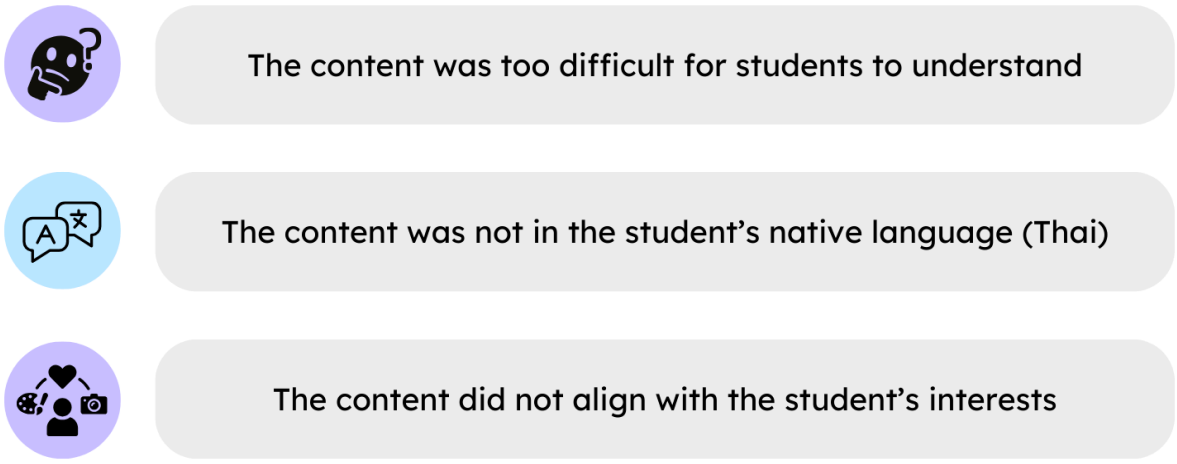


Figure 9: Barriers to Science Education in Thailand

However, the survey results also show that communication about topics in climate change, energy, and biotechnology was strong, indicating that there is a desire from students to learn about science concepts that fit their interests. The students require information that is easy to understand and fits their interests.

2.6 - Current Efforts to Build Scientific Literacy Among Thai Youths

According to Miller (1983), the most effective place to start expanding public scientific literacy is in elementary and secondary schools, so this project will focus on secondary school students, specifically grades 10-12. To build scientific literacy among youths, various methods should be used to make the content easier to understand. These methods include considering the students' background, explanations with simple language, providing examples, and using media for extra learning (Suwarat & Chanunan, 2023). This would increase the students' confidence since they'll be able to better understand science and they'll realize that it is not so complicated to get into the science field. Activities, projects, and challenges that aim to inspire, encourage, and promote science to the public will help overcome the barriers mentioned previously and

make science more accessible (Chen et al., 2019a).

2.6.1 - The National Science Museum

The National Science Museum (NSM), a state enterprise located in Pathum Thani (North of Bangkok), aims to increase public interest and awareness in science and technology (Chen et al., 2019a). The NSM currently operates four museums, with a fifth one under construction. They also offer online tours of their museums so the public can access the museum from the comfort of their own homes (The National Science Museum, n.d.). The NSM has a Youtube channel that hosts various science programs that are suitable for a wide variety of audiences.

Other than museums, the NSM also operates a learning center called "NSM Science Square" in Ratchada, Bangkok. The learning center offers various activities that encourage lifelong learning and provide families with educational experiences. The NSM has an online store that sells items that will make science enjoyable for children like toys, craft kits, and experiment kits.

2.6.2 - National Science Festival of Thailand

Organized by the NSM, The National Science Festival of Thailand (NSFT) is an annual two-week event that aims to "promote science, encourage learning, and prove that science is for everyone" (Chen, 2014, p. 1). The event is able to bring in a large audience due to the spectacle of the exhibits and still provide an educational and enriching experience. The various activities available to attendees ensure that there is something enjoyable for everyone, regardless of age or interests. Examples of these activities are shopping, competitions, and workshops.

The NSM has two strategies to attract visitors who are not already interested in science. The first strategy is to offer visitors fun and interesting experiences with science. Certain topics

such as “Light and Laser” can be made into an exhibition booth. This method of presentation makes it more appealing to visitors. In order to make the experience more appealing and relevant, trending topics and issues are used as the theme of these particular exhibitions. The second strategy is to have famous young actors as the fair hosts to draw in younger audiences and make science seem less intimidating and more inclusive (Chen, 2014).

2.7 - Encouraging Youths to Become Science Communicators

In order to encourage youths to become science communicators, they need to see science as a source of achievement and wonder. Encouraging youths to become science communicators can affirm those who already have an interest in science and benefit others who are not interested in or struggle with science. Having youths become science communicators gives their struggling peers a more relatable guide and makes science seem less intimidating.

FameLab is a communication competition to encourage and support students as science communicators (British Council., n.d.). In FameLab, contestants are to engage and entertain the non-scientific audience by giving short presentations about the latest scientific research topics in a way that the audience can easily understand. FameLab provides contestants with an intensive masterclass to improve their science communication skills. FameLab not only builds on contestants' communication and presentation skills, it also develops a network of future science communicators. FameLab was launched in Thailand in 2015 and is held annually. The NSM, a long-standing partner, has been the program organizer since 2022. FameLab contestants are older than the target demographic for this project, but there is a spin-off project adapted to fit in a school setting that we can take inspiration from.

2.8 - The Principia

Our sponsor, The Principia, produces articles on their Facebook page and their website regarding science and technology with the intention of igniting passion among Thai youth. They cover a wide variety of scientific topics such as physics, chemistry, technology and more, essentially covering the topics that fall under the main core of the science curriculum. Their content is created by their team members who have relevant experiences and diverse backgrounds as educators and scientists in various fields. The Principia team members each specialize in a small range of topics.

The Principia team has organized many online and offline events to help make science more accessible. Their projects mainly focus on science communication and science engagement. An example of their efforts in promoting good science communication was a lecture they held at Kasetsart University (see Srivilas, 2023a, for more detail). The lecture covered the concept and importance of science communication, methods for communicating effectively, and career options that differ from the norm for science graduates like scientists, researchers, or professors. An example of their efforts in science engagement was a workshop they held at the Bangkok Design Week 2023 (see Srivilas, 2023b, for more detail). In this workshop, they discussed game-based learning, gamification, and the advantages of using games as an educational tool. They even gamified a section of their workshop in order to encourage bystanders to join the workshop. Their biggest project, to date, is organizing the Science Communication Festival 2023 (Science and Art: ศาสตร์และศิลป์; see The Principia, 2023, for more detail). Previously, the youngest audience The Principia team had worked with were university level students. They now are looking to target younger audiences and plan to create a project that is specifically for Thai youths.

In addition to hosting events, The Principia spreads awareness about their content through various social media platforms. While these posts do convey interesting information, their posting frequency and style could be improved. Studies show that many secondary students utilize social media to get their news (Ku, et al., 2019). The Principia is present on both Facebook and Instagram, but could increase their engagement by exploring different content types. More interactive posts such as videos, polls, and giveaways have been shown to attract a wider audience (Ryhänen, 2019). Attracting a larger audience can create more opportunities for the public to learn about science and build their scientific literacy.

2.9 - Scientific Literacy Leading to a Better Society

Scientific literacy plays a key role in shaping society. It allows people to be knowledgeable and make well-informed decisions, bridging the gap between scientific knowledge and public understanding (Garbazcz, n.d.). Science is involved across various fields, from technology, and communications, to industry, emphasizing its importance in everyday life and culture (Espinosa, 2005). Acknowledging its importance extends beyond technological advancements, as it has enormous economic implications.

Individuals are able to make informed decisions when being scientifically literate. Misconceptions were revealed in surveys conducted by Oklahoma State University about DNA on food labels (Garbazcz, n.d.). In the survey, people were asked about whether “DNA” needed to be included on food labels. Half of the respondents wanted the food to be labeled if DNA was in the food. This indicated that they did not understand what DNA is since DNA would surely be contained in food prepared from plants or animals. This lack of awareness leaves the respondents vulnerable to misinformation. Having general scientific knowledge as well as being scientifically literate enables critical analysis, accurate evaluation of information, and informed

decision-making.

In addition, after the COVID-19 pandemic, the importance of scientific literacy in addressing global challenges has received a lot of attention. Research indicates that a decline in global engagement with science subjects, along with concerns about cultural diversity issues, emphasizes the need for diverse approaches in science education (Valladares, 2021). Transforming science education from just general knowledge to including engagement in, for example, social science activities is crucial to help individuals cope with current and future global challenges effectively. Scientific literacy not only allows people to make informed decisions but also helps people generate ideas to solve problems effectively.

Furthermore, scientific literacy is tightly linked with human history and cultural heritage as it is the driving force for the technological advancements of humanity, such as steam engines (Espinosa, 2005). Scientific literacy initiatives across all age groups can help to create a strong connection between individuals in society and scientific knowledge (Garbazcz, n.d.). In addition to enriching its cultural heritage, by promoting an appreciation for the cultural relevance of science as well as improving scientific literacy, society can build a strong foundation.

Lastly, investments in scientific research consistently yield high economic returns, averaging 30% annually over the last 50 years, according to the studies referenced from the Committee on Economic Development and the U.S Congress' Science Committee (Espinosa, 2005). Technological innovations derived from scientific discoveries illustrate how scientific literacy can create innovation, drive economic growth, and create employment opportunities. Society can benefit from both technological advancements as well as economic growth through improving scientific literacy in populations.

2.10 - Summary

Scientific literacy can be defined as having a broad, but practical knowledge of science. Science communication is the act of sharing scientific knowledge and information, while science engagement refers to the interactions between the scientific community and the general public. Both science communication and science engagement tie into scientific literacy, and are essential for a well-informed society. Effective science engagement should ensure that the public is interested in science, while effective science communication should further ensure that the public is knowledgeable and up-to-date.

The structure of Thai education influences students' interest in science. A student's concentration in the upper secondary level will affect their interest in the science field. Additionally, the teaching style of different teachers and schools will impact a student's interest in science, and their overall willingness to pursue a career in science. Efforts to increase interest in science already exist in Thailand via museums, scientific experiences for all ages, and opportunities to connect with like-minded individuals.

With our target demographic in mind, it is important to recognize that the reason teenagers stray away from science is due to the disinterest curated from different factors. Academic, scientific challenges presented in an outdated manner create a less enjoyable experience for students possibly contributing to a disinterest in a subject. Youth in general show some interest in science within their daily lives, so presenting topics that align with their interests in a simple manner should increase their understanding and heighten their motivation to engage with science.

Improving scientific literacy may lead to a better society as a scientifically literate public could make more informed decisions regarding public policies. A scientifically literate society can benefit the economy by leading to more technological advancements and innovation. Increasing scientific activity like research would create more investment opportunities.

All the methods and examples that were discussed in this chapter will help us develop an effective strategy to help The Principia team expand their reach to younger audiences.

3. Methodology

The goal of this project was to assist The Principia in improving scientific literacy among Thai youth in the upper secondary level. In order to achieve this goal, first we collected data to understand students' current interest in science. Then using that data, we identified and developed key Inquiry and Project Based Learning principles. Utilizing those principles, we designed and hosted an interactive science event to engage youth and increase science interest. Finally, we created a sustainability plan for The Principia so they could continue building scientific literacy among Thai Youth. In this chapter, we describe the methodology we developed to gather and analyze the perspective of our target population.

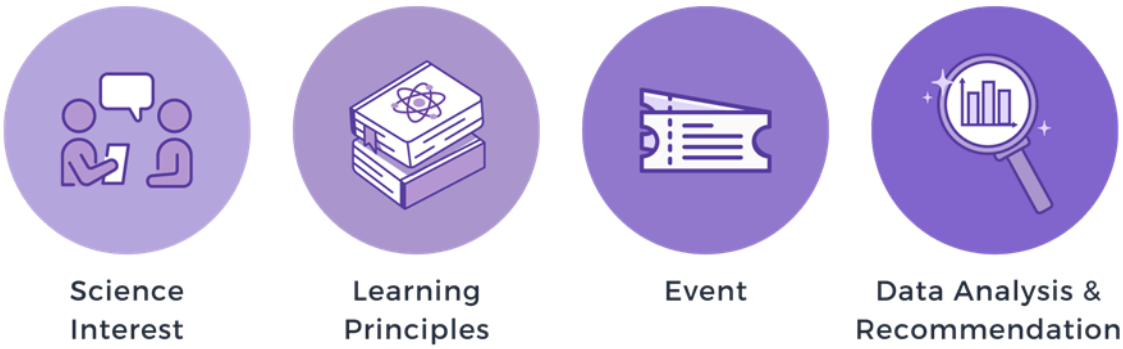


Figure 10: Project Objectives

3.1 - Objective 1: Current Science Interest

Measure the current scientific interest among Thai youth.

In order to evaluate our target population's interest in science, we needed to collect data from the students. Focusing on upper-secondary students, we collected both quantitative and qualitative data in survey format. We also evaluated current efforts to increase students' interest in science. Collecting quantitative data allows us to compare data over time, while qualitative

data provides more open responses that can be evaluated to identify trends. Evaluating current efforts, we identified what was working well for students, and what still needs improvement. In order to collect data from students, we created and distributed surveys to the students via QR code. In order to evaluate current efforts, we observed preexisting events that targeted the same population. Survey questions were based on the following research questions used to establish our information needs.

- What currently interests students in science?
- How do students receive science information?
- How do students prefer to learn?

3.1.1 - Surveys

Surveys were chosen as the primary method of collecting data as they maintain objectivity and offer flexibility for participants to respond. Using our research questions, we formulated survey questions specific to student knowledge, interest in science, their social media usage, and their learning style. Additionally, survey questions were developed based on a 2007 study that evaluated students' attitudes towards science (Barmby, et al., 2007). The researchers developed questions that evaluated a student's learning in school, outside of school, and their future participation in science. They found that this model was effective in evaluating a student's attitude towards science. A full set of questions asked in the surveys can be found in Appendix B.

The questions regarding science were used to gauge students' overall interest in science and how they believe they could become more interested whereas questions pertaining to social media were used to determine the best method of advertising our event. Furthermore, we asked

about learning style to determine what type of solution we should implement to improve scientific literacy.

Our survey was created using Google Forms and was available in both English and Thai for a user-friendly experience. Additionally, the survey was broken into multiple sections, including a consent section, general questions, event-specific questions, and contact information. The survey used a combination of multiple choice, and open-ended questions that covered all of the previously mentioned topics.

3.1.2 - Distribution of Surveys

In order to access our sample population, we took advantage of several existing events hosted by Chulalongkorn University that were tailored to upper secondary students. These events are listed in Table 2.

Table 2: Survey Distribution Events

Date	Event
12/1	BSAC Admissions Interviews
20-21/1	Chulalongkorn University Open House
24/1	MIT Nobel Laureate Guest Speaker (Quantum Dots: Discovery & Synthesis)
27-28/1	Chem See You Camp

Each of these events, located at Chulalongkorn University, created an opportunity for us to collect students' names and emails so they could be contacted with details on the scientific event we were planning to design. In addition to collecting contact information, at the events following BSAC admissions interviews, we started collecting pre-survey data to collect qualitative data.

The Open House event also included several lab sessions for the students, which we observed. This process is described in Section 3.2. Following the Open House event, we started promoting our sponsor, The Principia. Students who completed our survey received a promotional keychain from The Principia.

In addition to interacting with students at these events, we also were able to distribute our pre-survey through our sponsor's networks. Some members of The Principia also work in the education field, and have connections with local high schools. Therefore, they were able to distribute our survey to more students through their contacts.

3.1.3 - Use of Collected Data

The responses collected from the surveys helped formulate ideas for our event, taking into account how our target population learns, and what sparks their interest in science. Through categorizing the data, we could identify trends and develop learning principles that we wanted to highlight in our event.

Due to the language barrier, only half of the team was able to efficiently communicate with our target demographic. This prevented the team from working at our highest capability since there was a delay in translations and missed opportunities if our Thai team members were already busy speaking with another student. Additionally, with 75% of our team being male foreigners, there was a concern of seeming unapproachable to the Thai students due to the potential difficulty in promoting inclusivity. Keeping these difficulties in mind, we were able to alleviate any challenges through the use of Thai language, professionalism, and greeting students with a smile. The data collected provided insight into student interest as well as potential ways to engage more students into science.

3.2 - Objective 2: Learning Principles

Develop Inquiry and Project Based Learning Principles

From our research regarding inquiry and project based learning, the pre-surveys conducted to understand current student interest as well as our lab observations of students engaging with scientific concepts, we developed these key learning principles that would drive our goal of building scientific literacy among Thai youth.

Our first activity was to observe groups of upper secondary students who participated in lab activities during Chulalongkorn University's Open House event as well as during Chem See You Camp. A few of our team members observed the lab and workshop activities that were taking place at both events.

For both events, the same team members observed each activity as well as took notes the same way. The team members who watched the Open House lab activities took notes on many different aspects. We took notes on how the facilitator communicated and engaged with the student as well as observed students' reactions while listening in on their conversations. We did not interview or directly talk to any students during the observation, as we did not want to interfere with the activities. In addition, we noted the content of the lab itself and how the material was presented (e.g. if the principles were explained before or after the experiment was completed). We then compared both observations and noticed that the Open House chemistry lab had more positive remarks compared to the microbiology lab.

Once we established what interests students, the next challenge was to innovate unique and user-friendly activities that would be simple yet exciting while providing familiarity to students for further engagement in science. The principles created to "defeat" this challenge were a combination of inquiry based and project based learning principles found within our research

that prioritized hands-on learning, simplified complex concepts through familiarity and tested the theory. Hands-on learning is vital to the students' education as it keeps them engaged while also allowing students to utilize more than one of their senses as they discover new concepts and theories (Bögeholz, et al., 2009). Furthermore, it's essential to simplify complex concepts, otherwise students will be left confused and with a disinterest to learn about such topics. One method to simplify difficult concepts would be through relating them to real life scenarios that students face. By relating difficult concepts to reality, students should be able to illustrate the concept clearly. Once the concept had been understood, we tested how well students have absorbed the information. Rather than distributing an exam, we opted for a presentation route as studies show that exams do not measure intelligence for most students, just memorization, nor do they account for students' anxiety. Through a presentational format, students presented their findings while practicing effective scientific communication.

While creating these principles, we understood that we were encased into an eight week period to comprehend the current youth interest in science, innovate and implement engaging activities in order to analyze the data to create a solution for our sponsor. There were many moving aspects and factors that we wanted to address in regards to student interest in science as well as scientific literacy and communication but we had to focus on an attainable goal for the time constraint of our project. Despite diving deep into the idea of engaging students in science concepts and increasing their interest, we ensured a realistic and sustainable solution for The Principia given our timeframe.

3.3 - Objective 3: Event

Design and host an event utilizing learning principles to engage youth and increase scientific interest

Knowing the student's perspective on science as well as their interests allowed us to craft an engaging and interactive event that displayed new scientific concepts for them to explore. The event would catch the attention of students, teach them scientific concepts as well as build their scientific communication skills. To determine how we would catch the attention of students, we implemented a hands-on experiment that would explore a scientific phenomenon that they had not yet learned about. With one of our sponsors being an educator to upper secondary students, we discovered the topics studied in science. Furthermore, students were given the option of choosing from two experiments covering different topics.

The first experiment would focus on electrochemistry. The students would use electricity to deposit one metal onto another, by means of a process called “electroplating.” The students would easily connect a copper electrode to a keychain immersed in a solution of copper nitrate to a power supply, and the keychain will begin to be coated in copper. This experiment has a relatively simple setup so that the students could perform it without much difficulty. Also, it gives the students different variables to experiment with, making it more engaging. For example, they could vary the metal to be coated onto the keychain and observe how it affects the coating process in terms of speed of coating and the visible color of the coated metal. Additional details about this experiment can be found in Appendix J and Appendix K.

The other experiment would focus on the concept of surface tension. In this experiment, the students would test the ability of different surfactants to reduce the surface tension of water by using them to propel a boat of their own making forward. This experiment is easy to perform and so safe that the students could even perform it in their own homes. Additionally, this experiment also gives the option for the students to choose variables. For example, they could vary the surfactants used and see how they differ in terms of how far the boat is propelled

forward. This could later be related to the chemical structures of these surfactants, giving a chance to teach the students some chemistry concepts. Also, they could vary the shapes of their boats and again see how the shape affects the distance traveled by the boat.

Utilizing an inquiry based learning methodology, guiding questions led the students to discover the theory behind the experiment. The effectiveness of this method of teaching was later tested by allowing the students to use the theories that they just learned to target a specific problem that they see in their everyday lives and use the theory that they learned to conceptually come up with a product that could potentially solve that problem. Lastly, they were given the chance to practice scientific communication by pitching their ideas to a panel of judges. The judges for the pitch were university professors that are highly experienced and specialize in the areas of the experiments that the students just performed, as well as a representative from The Principia.

About a week before the event, the judges were provided with a rubric that we developed so that they would be able to fairly and accurately assess the students. The rubric, as seen in Appendix L, was divided into four categories, content, clarity, presentation, and organization. These categories allowed for the evaluation of the student's ability to understand the concept, as well as explain it to an audience.

3.4 - Objective 4: Sustainability Plan

Create a sustainability plan for The Principia.

We decided that the best method of delivering our results to The Principia was through a sustainability plan. A sustainability plan in regards to a project is a document that describes how a project can be sustained for a long time (Wieners, 2021). In our case, we created a

sustainability plan for The Principia that outlines our solution to how to continuously increase scientific literacy of Thai youth.

We chose to create a sustainability plan because it clearly outlines each part of the initiative, and can be broken into multiple sections that can be focused on independently. Additionally, the sustainability plan model not only examines the project itself, but also the effects it has on The Principia, and the surrounding community.

A sustainability plan can include many different elements that contribute to the overall plan. We chose to focus on the following elements to create recommendations (Morfaw, 2014; Wieners, 2021). Firstly, **mission** refers to having a coherent purpose or goal for the organization. **Evaluation** includes having a strong method to evaluate success. **Adaptability** refers to the ability to adapt to changing circumstances. **Scalability** on the other hand refers to the ability to scale capacity or capabilities up or down. **Integration** focuses on being able to integrate with existing systems such as a school curriculum. Finally, **community** examines the support from the community for a given project. The selected elements highlight some of the values that are important for The Principia and those that will encourage the continued success of our initiatives.

An additional part of our sustainability plan for The Principia includes a comparative analysis of their Instagram account. Specifically, we examined their account's reach, engagements, and followers over a seven day period to determine if interactive workshops increase social engagement. This period was chosen to start three days before our event, and end three days after the event in order to measure the impact an interactive workshop had on their social media engagement. In addition to our event, The Principia was also hosting another event within that time frame, allowing us to further examine the effects of these types of initiatives.

The data collected from Instagram allowed us to make specific recommendations regarding how The Principia should pursue their social media engagement.

4. Results

Our goal was to assist the Principia build scientific literacy among Thai youth. Every step in the process focused on a specific objective. Through our lab observations and survey data collection, we developed the following findings regarding current scientific interest levels, learning principles as well as factors relating to student engagement within interactive workshops.

4.1 - Pre-Event

Finding 1: Publishing content on Instagram will reach upper secondary students

Instagram is the most popular social media platform among upper secondary students. Out of 181 pre-survey responses, about forty-seven percent of students utilize Instagram the most, with YouTube and TikTok running a close second place at seventeen percent, shown in Figure 11.

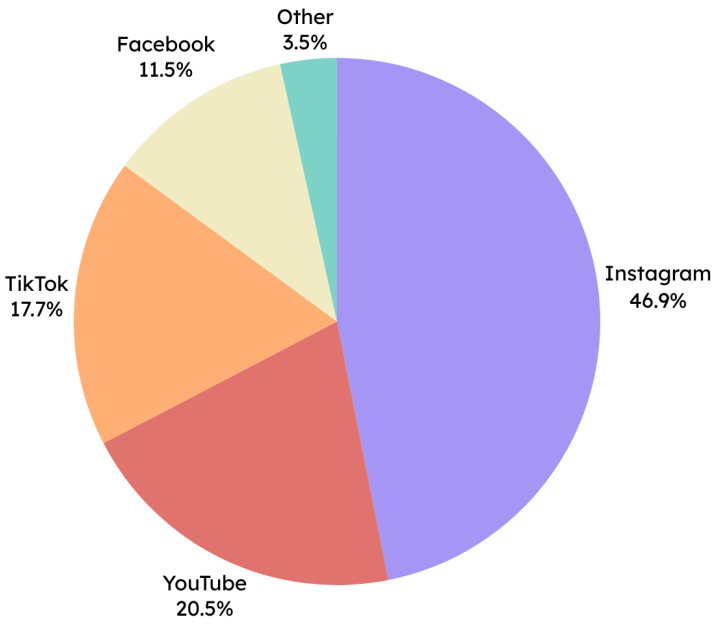


Figure 11: Percentages of Most Used Social Media Application (N = 181)

Out of the sample population utilizing Instagram the most, seventy percent of Instagram users spend four or more hours on the platform daily, shown in Figure 12.

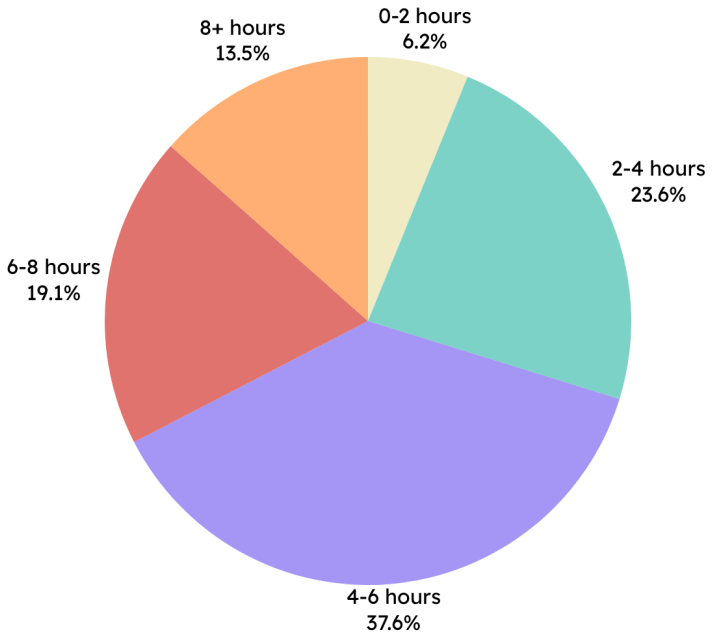


Figure 12: Hours Spent Daily on Social Media (N = 181)

Since students spend the most amount of time on this platform, publishing palatable and shareable content through Instagram will reach broader audiences. Some limitations this could bring is that content on this platform may not reach the older generations.. Although this is a possibility, content can still be produced on all social media platforms - the only difference is that the audience on each platform will differ. Therefore, all generations could be targeted in order to spread awareness about scientific literacy.

After we held the event, we saw an increase in how many people saw The Principia's post on their Instagram and the number of people that engaged with their posts. We found that on the day of the event, The Principia had a 446% increase of their impressions on their posts, meaning that more people kept coming back to view their posts multiple times. Having high impressions on your Instagram posts is a good sign that the posts are doing well, so the posts about our event did very well compared to The Principia's other posts. One note, however, is even though the reach and engagement increased on the day of our event, they went back down to the levels they were at before the event, and they did not gain any followers, so it seems that our event may not have affected their Instagram page in the long run.

Finding 2: Hands-on activities that are fun and relatable increase interest in science

In order to increase interest in science, students should find it relatable, fun, engaging, and hands on. Out of our 181 pre-survey responses, we found that 87% of our survey participants were already interested in science. Following up, we then discovered that their interests stem from science being fun, their passion for discovering the world around us as well as the possibilities of human and technological advancement. Furthermore, when learning about the different factors that could potentially increase interest in science, we found the responses to be representative of the five categories shown in Figure 13.

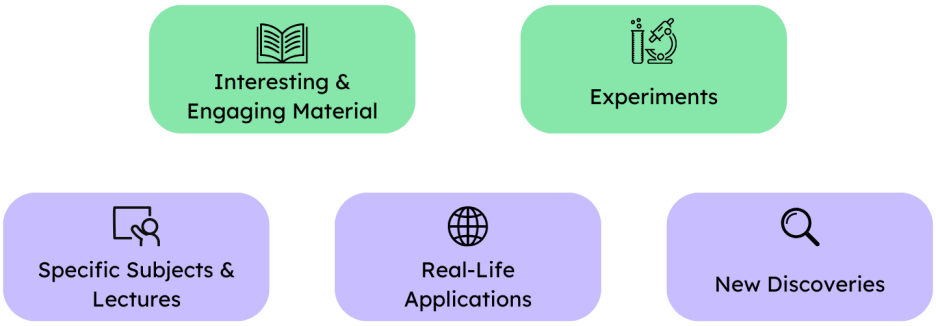


Figure 13: Response Categories for Students' Interest in Science

Utilizing all this data collected, we found this method to increase interest in science through hosting a hands-on and engaging event. A hands-on event is not the only method we could have implemented based on the data that we gathered. For example, we could have created an event that showcases news and discoveries in science and this type of an event could have been equally or more effective to increase interest in science than the hands-on event that we created.

Finding 3: Inquiry based learning is an effective method for students to learn

Based on our observations, we discovered that inquiry based learning is another effective method to increase interest in science among youth. To understand how to teach students utilizing inquiry based learning, we observed two different labs, in Thai, during Chem See You Camp and Chula Open House that directly worked with secondary students. During these labs we found the students engaged and excited to learn. We took note of what worked and what didn't so that we could implement the successes to our event. Through further discussion with the participants and facilitators, we found the highest success rate for student satisfaction and comprehension when the material had a storyline making the concepts relatable, had guiding questions that allowed the students to come to their own conclusions as well as conducted hands-on experiments. When speaking to the facilitators at these lab sessions, we also discovered that these attributes displayed inquiry based learning. The guiding questions during the labs were developing students' critical thinking skills.

Another manner of inquiry based learning allows students to think creatively. Through the post-survey responses, we found that independence during experimentation leads to new

theories. Eightyone percent of students enjoyed the freedom to experiment in the lab. Students electroplated nails with zinc, copper and lead, only to decide which metal they would want to use to coat their own keychain. Their responses stated how amazed they were by visually seeing the object get electroplated which made them wonder how exactly electroplating worked. Students mentioned how by creating a visual, hands-on representation before understanding the theory, they were able to hypothesize and think more about electrochemistry.

Finding 4: Upper secondary students prefer visual and kinesthetic learning

Our next finding is split into two sections due to the different data collection time, but can be narrowed down to upper secondary students preferring visual and kinesthetic learning over auditory. While we were still gathering data to measure the current science interest among youth, we found that 81% of the survey participants were visual learners seen in Figure 14.

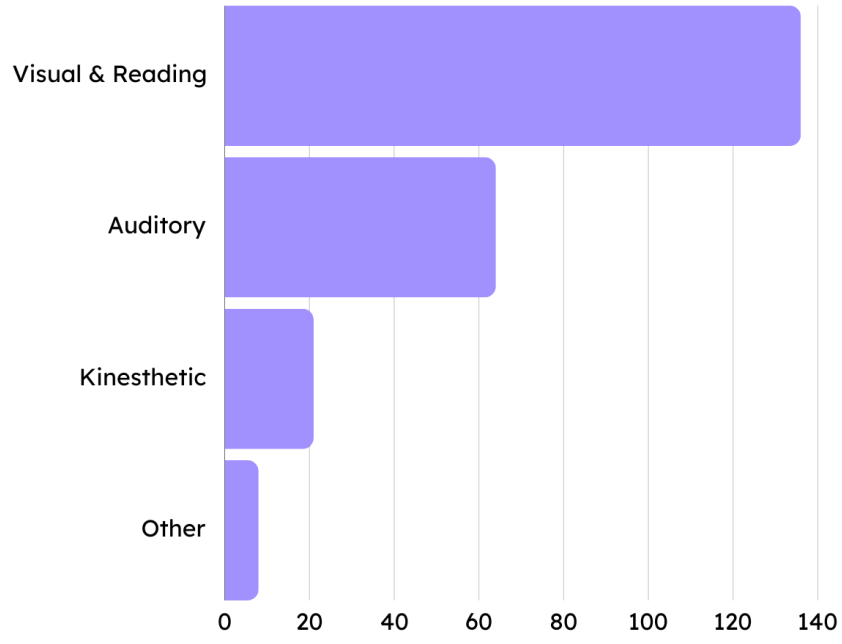


Figure 14: Pre-Survey Responses for Type of Learner (N = 181)

This data set consisted of 181 participants and came from various backgrounds. After hosting the event, the post survey found that the students who attended were visual and kinesthetic learners equally balanced out. The students registered for the event had already known that a hands-on experiment would take place. Therefore, to no surprise, nearly all students mentioned they enjoyed the practical aspect of the event and, when asked what we could improve about the event, had mentioned more hands-on activities in the lab, a common theme across post-survey responses. One response said "... This demonstrates how the process works, creating a visual representation of electrochemistry for students to visualize and learn. There's nothing I don't like about the lab but it would be better if we can do different experiments as well."

4.2 - Post-Event

Finding 5: Upper secondary students find electrochemistry more unique than surface tension

Based on our pre-survey data, we found that students prefer electrochemistry due to its uniqueness. Initially, for the event, we planned to host two activities so students would be able to experiment with electroplating keychains or surface tension through soap boats. While conducting the registration for the event, students were asked what concept they would prefer experimenting with. Through registration, we found that eight percent of students chose the electrochemistry experiment and the remaining twenty percent chose no preference. Those who chose electrochemistry were the same as those who mentioned in their pre-survey responses that electrochemistry was a new concept for them and could be a field they want to study. This presented a challenge, as we had already planned to have two lab groups with twenty-five students each, working on one of the two experiments. Regardless, since our goal was to increase

interest in science, we decided to just do the electroplating experiment with all the students who registered. In our pre-event survey, we discovered that students who had chosen electroplating over surface tension found electrochemistry more interesting, unique and aesthetically pleasing.

Finding 6: Increased usage of accurate keywords indicates higher levels of scientific literacy

In order to gauge how effectively the students were able to communicate their pitches, which related to electrochemistry, we developed a list of keywords that corresponded to electrochemistry (see Figure 15).

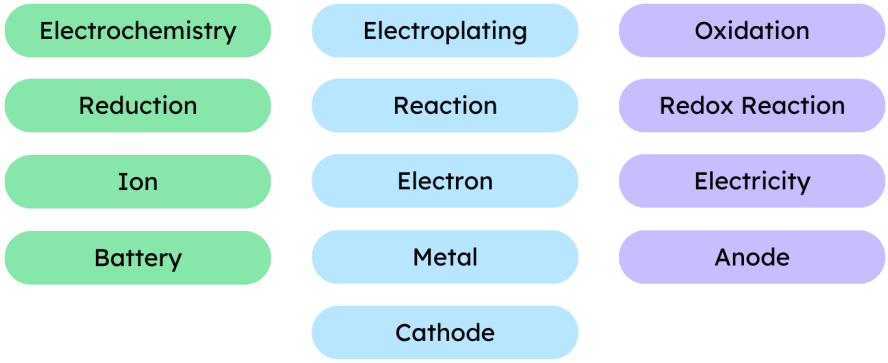


Figure 15: Selected Keywords in Student Pitches

We determined that the number of keywords utilized correctly, during a student's pitch, led to them effectively communicating science which would indicate a higher level of scientific literacy. Furthermore, of the ten groups that presented pitches, the teams in first and second place had the highest percentage of keywords used accurately at forty six percent whereas the third place team was at thirty-eight percent. Compared to the team that had the lowest score from the rubric, there was a twenty-three percent difference in usage of correct keywords. However, the percentage use of keywords is not the only way to quantify the students' science literacy; For example, we could have performed a more traditional exam to see how much of the concept they

understood but we did not go in this direction as we wanted to keep the event fun and interactive. Additionally, we found that the category with the highest average score on the rubric was content, meaning that all students that attended comprehended the concept of electrochemistry.

Finding 7: Enthusiastic hosts and comfortable environments positively influence student engagement when learning

To develop scientific literacy among youth, an enthusiastic host and comfortable atmosphere will positively influence student engagement. Our post-survey responses gathered that seventy percent of students felt the welcoming nature of the hosts created an atmosphere in which the students could think critically and freely. Seventy-three percent of students felt comfortable around the facilitators to ask them questions as well as implicitly learned. The energy and passion that the hosts radiate will thus be influencing the learning of the students.

Finding 8: Collaboration creates opportunities to develop critical thinking skills

Through our observations during the event as well as from our post-survey responses, we found that collaboration among peers increased critical thinking skills. **Fifty-two percent** of students found that they learned more from discussing with one another about various concepts in electrochemistry, were fascinated by their peers' pitches as they acquired intriguing knowledge, and happy that they made connections. Additionally, after each presentation, groups were asked in-depth questions regarding their product in which they had the ability to discuss as a group to answer. This allowed audience members as well as presents to question and further understand the concept. Event features like these lead towards students developing critical thinking skills that will be useful for their futures.

4.3 - Chapter Summary

Our findings demonstrate how to engage with youth in order to increase their interest in science by presenting various activities that intrigue students. We discovered various approaches that engage youth to be interested in science such as visual and kinesthetic learning environments, enthusiastic and approachable hosts, and collaboration within groups. With these discoveries in mind, we conclude that engaging, hands-on activities that are taught through inquiry based learning and promoted on Instagram will assist The Principia in building scientific literacy among Thai youth.

5. Conclusion & Recommendations

In order to improve scientific literacy among Thai youth, we can increase interest in science through engaging workshop events that highlight unique concepts, and challenge students to effectively communicate their ideas. Thus, we recommended The Principia to engage with students through instagram, to utilize a variety of strategies to build scientific literacy as well as to form partnerships with other organizations to strengthen their efforts.

1. Engage with students through Instagram

By analyzing how students best receive information, both socially and educationally, we identified that the most efficient way to engage with students is through Instagram. The Principia can increase interactions with youth by creating more engaging content, such as short videos or polls. These methods can attract more viewers, greatly increasing The Principia's reach. In order to evaluate the efficacy of the Instagram initiatives, the insights and performance of the Instagram account can be constantly reviewed to identify trends and growth.

2. A handful of strategies should be used to increase scientific literacy

Our survey responses indicated that the manner in which information is presented to the students is very important. We recommend that at events that are designed for students, the facilitators should remain the same throughout the entire event, and should create a comfortable and enjoyable environment. Additionally, we recommend that guiding questions are asked throughout the lesson and lab to further engage students and promote critical thinking. Finally, in smaller groups, students are able to learn more efficiently both in terms of time management and are more engaged during group discussions.

The use of inquiry based and project based learning is very effective in teaching new ideas and ensuring student success. Specific concepts that can be targeted include hands-on learning, simplifying concepts, utilizing guiding questions, and highlighting applications to real life. Implementing some or all of these strategies should greatly increase students' interest in science.

When researching the ways in which students best learn, we often found that hands-on activities lead to the best results. As opposed to lecture style, interactive activities allow students to experiment on their own, and form their own conclusions. Through a collective group discussion, concepts can be explained to ensure accurate comprehension of the experiments performed. These interactive activities can range from lab experiments to creative presentations in small groups.

Another important consideration when encouraging students to become more interested in science is the topic used. Utilizing the macroscopic level of representation, students are able to connect more with the concept and form their own conclusions. Additionally, using a unique topic requires students to use critical thinking to fully understand the topic.

It is important to create a low pressure environment for students to learn in. Often students are in high stress classes that have larger consequences (exams, grades, etc.). However, low stress environments are much more welcoming for students. We found that by creating a low pressure environment, students were more engaged and willing to learn.

Lastly, any instructions for students should be stated clearly before the activity begins. This is to ensure that students are not confused during the activity and that they perform the correct tasks assigned to them. By doing this, the host can get the intended result from the students and any data collected would be accurate.

3. Form a partnership

As a concrete action that The Principia could take to sustainably further their mission of increasing scientific literacy among youths, we recommend that The Principia find a partner organization that has easy access to chemicals and labs so that they may conveniently host events that include a hands-on experiment element. One such organization would be the Faculty of Science, Chulalongkorn University. Through this project, The Principia already has experience working with this organization and have successfully hosted an interactive science event. The findings and data collected from this event could be used to propose a partnership that would be mutually beneficial to both parties.

Table 3: Summary of Recommendations

Recommendation	Details
1. Engage with students through Instagram.	We recommend that The Principia focus on increasing their presence and creating more engaging content to better attract students. Additionally, when students enjoy their experience at an event, they will share through Instagram, which will increase social media engagement and attract new followers.
2. Increase scientific literacy through several strategies.	Based on the results from our event, survey responses, and prior research we concluded that it takes several strategies to best increase scientific literacy. We recommend that The Principia focus on implementing these strategies in their events to achieve optimal results. ● Present information in engaging methods ● Implement Inquiry and Project Based Learning ● Perform interactive activities ● Utilize unique scientific concepts ● Create a low pressure environment ● Make all the instructions very clear

3. Form a partnership	We recommend the Principia form a partnership with an organization that has easy access to lab materials and spaces to continue hosting events that include interactive experiments.

5.1 - Limitations

Several limitations arose throughout this project. Firstly, the language barrier was a large hurdle to overcome. As we were working with students from various schools and programs, we interacted with a mix of Thai and English speakers. This resulted in difficulty in communicating ideas and instructions. However, this was overcome by being patient and relying on our Thai partners to assist in discussions. In the future, forming a strong team of both English and Thai speakers is very important.

Additionally, another notable limitation in our sample population was that many of the students we interacted with were already interested in science, and sought out events similar to ours. While this allowed us to understand why students are interested in science, we were unable to access a population of students that are not already interested in science. Future research could explore how our recommended initiatives affect students who are not initially interested in science.

5.2 - Project Conclusion

The goal of this project was to assist The Principia in improving scientific literacy among Thai youth in the upper secondary level. We found that the most effective way to increase interest among youth was through engaging, hands-on activities that were taught through inquiry based learning. To initiate improving science literacy, The Principia can connect with youth via Instagram where they engage with the target demographic through stories, polls, or posts. By implementing these recommendations, The Principia has the potential to improve scientific

literacy among all youth in Thailand. These recommendations and potential improvement in scientific literacy can provide an opportunity for The Principia to broaden their audience as well as potentially increase the science workforce.

References

Adhikari, B., Hlaing, P. H., Robinson, M. T., Ruecker, A., Tan, N. H., Jatupornpimol, N., Chanviriyavuth, R., & Cheah, P. Y. (2019). Evaluation of the Pint of Science festival in Thailand. *PLOS ONE*, *14*(7), e0219983. https://doi.org/10.1371/journal.pone.0219983

Bangkok Post Public Company. (2023). Thai students score poorly in maths, reading, science. *Bangkok Post*. https://www.bangkokpost.com/thailand/general/2699504/thai-students-score-poorly-in-maths-reading-science

Barmby, P., Kind, P., & Jones, K. (2007). Developing Attitudes towards Science Measures. *International Journal of Science Education*, *29*(7), 871–893. https://doi.org/10.1080/09500690600909091

Basic Education Core Curriculum B.E. 2551. (2008). Ministry of Education Thailand. http://nasan.ac.th/_files_school/84103917/data/84103917_1_20210122-091311.pdf

British Council. (n.d.). *About FameLab Thailand | British Council*. Retrieved January 11, 2024, from https://www.britishcouncil.or.th/en/famelab/about-competition

Buck Institute of Education. (n.d.). *What is PBL?* PBLWorks. Retrieved February 22, 2024, from https://www.pblworks.org/what-is-pbl

Chen, G. (2014). National Science Festival of Thailand: Historical roots, current activities and future plans of the National Science Fair. *Journal of Science Communication*, *13*(04). https://doi.org/10.22323/2.13040304

Chen, G. (2022). Policy perspectives of challenges and factors in promoting science literacy in Thailand. *Kasetsart Journal of Social Sciences*, *43*(1). https://doi.org/10.34044/j.kjss.2022.43.1.33

Chen, G., Ratanaubol, A., & Sonchaeng, P. (2019). Thai youth engagement in scientific information in out-of-class context. *Journal of Yanasangvorn Research Institute Mahamakut Buddhist University*, *10*(2), 25–40.

Chen, G., Ratanaubol, A., Sonchaeng, P., Sumritdee, C., & Maneerat, P. (2022). Policy perspectives of challenges and factors in promoting science literacy in Thailand. *Kasetsart Journal of Social Sciences*, *43*(1), 245–250. https://doi.org/10.34044/j.kjss.2022.43.1.33

Chen, G., Sonchaeng, P., & Ratan-aubol, A. (2019). Civic science literacy in Thailand: The role of scientific communities to support lifelong learning. *ScienceAsia*, *45*(4), 299–300. https://doi.org/10.2306/scienceasia1513-1874.2019.45.299

Communicating Science Effectively: A Research Agenda. (2017). National Academies Press. https://doi.org/10.17226/23674

Council, B. (XXXX). *About FameLab Thailand*. https://www.britishcouncil.or.th/en/famelab/about-competition

Davies, S. R., Halpern, M., Horst, M., Kirby, D., & Lewenstein, B. (2019). Science stories as culture: Experience, identity, narrative and emotion in public communication of science. *Journal of Science Communication*, *18*(05). https://doi.org/10.22323/2.18050201

DeBoer, G. E. (2000). Science literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, *37*(6), 582–601. https://doi.org/10.1002/1098-2736(200008)37:6

Empowering Tunisian youth to become science communicators. (n.d.). EU Neighbours. Retrieved January 11, 2024, from https://south.euneighbours.eu/story/fahmologia-empowering-tunisian-youth-to-become-science-communicators/

Espinosa, J. M. R. (2005). The importance of scientific literacy in our society. In Y. Nazé, M. Stavinschi, & M. Vanherck (Eds.), *Astrophysics, and how to attract young people into physics. Joint European and National Astronomy Meeting 2005 Distant Worlds* (pp. 28–31). https://www.astro.uliege.be/RPub/Colloques/JENAM/proceedings/education/education_espinosa.pdf

Garbazcz, M. (XXXX). *What is Science Literacy and Why is it Important? Strategic Discussions for Nebraska*.

https://sdn.unl.edu/article/what-science-literacy-and-why-it-important#:~:text=Scientific%20knowledge%20helps%20people%20to,to%20people%20of%20all%20ages

Gilbert, J. K., & Treagust, D. (Eds.). (2009). *Multiple Representations in Chemical Education* (Vol. 4). Springer Netherlands. https://doi.org/10.1007/978-1-4020-8872-8

Graber, W., Erdmann, T., & Schlieker, V. (n.d.). *ParCIS: Aiming for Scientific Literacy Through Self-Regulated Learning with the Internet*.

Heinricher, A. C., Quinn, P., Vaz, R. F., & Rissmiller, K. J. (2013). *Long-term Impacts of Project-Based Learning in Science and Engineering*. 23.874.1-23.874.25. https://peer.asee.org/long-term-impacts-of-project-based-learning-in-science-and-engineering

Holstermann, N., Grube, D., & Bögeholz, S. (2010). Hands-on Activities and Their Influence on Students' Interest. *Research in Science Education*, *40*(5), 743–757. https://doi.org/10.1007/s11165-009-9142-0

Hurd, P. D. (1958). Science literacy: Its meaning for American schools. *Educational Leadership*, *16*(1), 13–16.

IPST, P. T. (2021, March 25). *ผลการประเมิน PISA 2018 การอ่าน คณิตศาสตร์ และวิทยาศาสตร์ (ฉบับสมบูรณ์)*. IPST - PISA Thailand. https://pisathailand.ipst.ac.th/pisa2018-fullreport/

Jucan, M. S., & Jucan, C. N. (2014). The power of science communication. *Procedia - Social and Behavioral Sciences*, *149*, 461–466. https://doi.org/10.1016/j.sbspro.2014.08.288

Kaiser, D., Durant, J., Levenson, T., Weihe, B., & Linett, P. (2014). *The evolving culture of science engagement*. Massachusetts Institute of Technology. http://www.cultureofscienceengagement.net/2013convening/report

Kakisako, M., Nishikawa, K., Nakano, M., Harada, K. S., Tatsuoka, T., & Koga, N. (2016). Stepwise Inquiry into Hard Water in a High School Chemistry Laboratory. *Journal of Chemical Education*, *93*(11), 1923–1928. https://doi.org/10.1021/acs.jchemed.6b00217

Kind, P., Jones, K., & Barmby, P. (2007). Developing Attitudes towards Science Measures. *International Journal of Science Education*, *29*(7), 871–893. https://doi.org/10.1080/09500690600909091

Kolstø, S. D. (2001). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socioscientific issues. *Science Education*, *85*(3), 291–310. https://doi.org/10.1002/sce.1011

Koomtong, N., Chomsuwan, K., Tanprasert, K., & Pinit, P. (2014). Science and technology learning model development to encourage Thai high school student to learning in engineering career. *2014 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE)*, 365–370. https://doi.org/10.1109/TALE.2014.7062564

Ku, K. Y. L., Kong, Q., Song, Y., Deng, L., Kang, Y., & Hu, A. (2019). What predicts adolescents' critical thinking about real-life news? The roles of social media news consumption and news media literacy. *Thinking Skills and Creativity*, *33*, 100570. https://doi.org/10.1016/j.tsc.2019.05.004

Lati, W., Triampo, D., & Yodyingyong, S. (2019). Exposure to Nanoscience and Nanotechnology Using Guided-Inquiry-Based Activities with Silica Aerogel To Promote High School Students' Motivation. *Journal of Chemical Education*, *96*(6), 1109–1116. https://doi.org/10.1021/acs.jchemed.8b00435

Laugksch, R. C. (1999). Scientific literacy: A conceptual overview. *Science Education*, *84*(1), 71–94. https://doi.org/10.1002/(SICI)1098-237X(200001)84:1

Lederman, N. G., & Zeidler, D. L. (1987). Science teachers' conceptions of the nature of science: Do they really influence teaching behavior? *Science Education*, *71*(5), 721–734. https://doi.org/10.1002/sce.3730710509

Miller, J. D. (1983). Scientific literacy: A conceptual and empirical review. *Daedalus*, *112*(2), 29–48.

Mitchell, S. L., McCourt, J. S., Nesset-Tollefson, D. J., Kimball, G. L., Mikesell, J. N., Tollefson, E. J., & Carlson, E. E. (2023). What's in That Medicine: An Inquiry-Based Activity to

Introduce Medicinally Active Natural Products and Metals. *Journal of Chemical Education*, *100*(1), 410–414. https://doi.org/10.1021/acs.jchemed.2c00836

Morfaw, J. (2014, October 26). *Fundamentals of project sustainability*. Project Management Institute. https://www.pmi.org/learning/library/fundamentals-project-sustainability-9369

Morrison, S. (2023). The story of Silicon Valley – How it began, how it boomed, and where it's headed. *Power & Beyond*. https://www.power-and-beyond.com/the-story-of-silicon-valley-how-it-began-how-it-boomed-and-where-its-headed-a-9836fd8f0adf6d3535810e709d99fec3/

Murcia, K. (2006). *Scientific literacy for sustainability* [[Doctoral dissertation, Murdoch University]. Murdoch University Library]. https://librarysearch.murdoch.edu.au/discovery/delivery?vid=61MUN_INST:ResearchRepository&repId=12135397440007891

Naukkarinen, J. K., & Bairoh, S. (2020). STEM: A help or a hinderance in attracting more girls to engineering? *Journal of Engineering Education*, *109*(2), 177–193. https://doi.org/10.1002/jee.20320

O.E.C.D. (2023). *Science performance (PISA*. https://www.oecd-ilibrary.org/education/science-performance-pisa/indicator/english_91952204-en#

Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47–61. https://doi.org/10.1016/j.edurev.2015.02.003

Plook TCAS. (2022). *What are the high school study plans?* https://www.trueplookpanya.com/tcas/article/detail/92354

Promboon, S. (2007). The science society of Thailand and its role in science and technology development in Thailand [Supplemental material. *ScienceAsia*, *33*(Supple. 1), 1–3. https://doi.org/10.2306/scienceasia1513-1874.2007.33(s1).001

Rubba, P. A. (1977). *[Nature of Scientific Knowledge Scale: Test and Users' Manual]*. Southern Illinois University.

Secondary/High School Education System In Thailand. (n.d.). Education Destination Asia. Retrieved January 11, 2024, from https://educationdestinationasia.com/essential-guide/thailand/thailand-secondary-education

Srivilas, T. (2023a). *The Principia บุก ม.เกษตรฯ ในโครงการ "ส่งเสริมการเป็นนักสื่อสารวิทยาศาสตร์มืออาชีพ*. https://theprincipia.co/sci-ku-and-the-principia-2023/

Srivilas, T. (2023b). *เรืองวิทย์ติดเกม*. https://theprincipia.co/science-in-game-workshop/

Suwarat, K., & Chanunan, S. (2023). Development of science communication abilities of 11th grade ethnically diverse students using phenomenon-based leaning in topic of respiratory system: การพัฒนาความสามารถในการสื่อสารวิทยาศาสตร์ด้วยการจัดการเรียนรู้แบบปรากฏการณ์เป็นฐาน เรื่อง ระบบหายใจ สำหรับนักเรียนระดับชั้นมัธยมศึกษาปีที่ 5 ที่มีความหลากหลายทางชาติพันธุ์. *Journal of Education Naresuan University*, *25*(3), 71–82.

The National Science Museum. (n.d.). The National Science Museum. Retrieved January 11, 2024, from https://www.nsm.or.th/nsm/en

Treagust, D., Chittleborough, G., & Mamiala, T. (2003). The role of submicroscopic and symbolic representations in chemical explanations. *International Journal of Science Education*, *25*(11), 1353–1368. https://doi.org/10.1080/0950069032000070306

Treise, D., & Weigold, M. F. (2002). Advancing science communication: A survey of science communicators. *Science Communication*, *23*(3), 310–322. https://doi.org/10.1177/107554700202300306

Valladares, L. (2021). Scientific literacy and social transformation: Critical perspectives about science participation and emancipation. *Science & Education*, *30*(3), 557–587. https://doi.org/10.1007/s11191-021-00205-2

What is STEM? Importance and teaching media of STEM Education (STEM education)? (n.d.). STEM คืออะไร ความสำคัญและสื่อการสอน STEM Education (สะเต็มศึกษา)? https://www.twinkl.co.th/teaching-wiki/stem-education-sa-tem-suksa

Wicaksono, A. (2022). Johnstone's Levels of Representation in Science Learning. *SPEKTRA: Jurnal Kajian Pendidikan Sains*, *8*, 19. https://doi.org/10.32699/spektra.v8i1.224

Wieners, E. (2021, March 21). Developing a Sustainability Plan in a Project Proposal. *proposalforNGOs*. https://proposalsforngos.com/sustainability-plan-project-proposal/

Appendix A: Informed Consent Agreement for Participation in a Research Study

Title of Research Study: Promoting Science Literacy Among Thai Youth

Investigator: Aman Hiregoudar, Amrit Kaur, Nicholas Kirby, Steven Oliner

Contact Information: gr-scilit-bangkokc24@wpi.edu

Sponsor: Principia Media

Introduction: Your child is being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort that your child may experience as a result of their participation. This form presents information about the study so that you may make a fully informed decision regarding your child's participation.

Purpose of the Study: This study focuses on the scientific literacy of high school students. The purpose of this study is to promote scientific literacy in youth by gathering data through online surveys.

Procedures to be followed: Participation in this study will include an online pre-survey not lasting more than 10-15 minutes regarding their interest in science. Additionally, your child will participate in an event (IonSpire Energizing Ideas) aimed at improving students' interest in science. The approximate duration of the event is 5 hours. This will include interactive experiments, and a short presentation in small groups. Finally, students will participate in an online post-survey not lasting more than 10-15 minutes.

Risks to Study Participants: Risks may include but are not limited to social or emotional discomfort due to survey questions or presentations. A WPI Institutional Review Board has reviewed and approved this study considering ethical considerations and the protection of human participants.

Benefits to research participants and others: Benefits include being able to participate in an interactive experiment, work with other high school students, and network with university professors.

Record keeping and confidentiality: All records will be kept online utilizing the platform of Google Forms in a password protected file and will stay anonymous. The information we are looking to gather will be relating to student inspiration regarding scientific concepts and social media usage. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB)

will be able to inspect and have access to confidential data. Any publication or presentation of the data will not identify you.

Compensation or Treatment in the Event of Injury: You do not give up any of your or your child's legal rights by signing this statement.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:

Investigators: Email: gr-scilit-bangkokc24@wpi.edu

WPI IRB Manager: Ruth McKeogh, Tel. 508 831- 6699, Email: irb@wpi.edu

WPI Human Protection Administrator: Gabriel Johnson, Tel. 508-831-4989, Email: gjohnson@wpi.edu

Your child's participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or your child, or any loss of benefits to which you or your child may otherwise be entitled. You or your child may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent for your child to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

Study Participant (Child) Signature	Date
Study Participant (Child) Printed Name	
Participant's Parent/Guardian Signature	
Participant's Parent/Guardian Printed Name	
Signature of Person who explained this study	Date

Appendix B: Survey Questions

Qualitative Questions

- How did you hear about this event? *(if applicable)*
- Are you interested in the Faculty of Science?
- Why are you interested/not interested in the Faculty of Science
- What other faculties are you interested in?
- If you utilize social media, which platform do you use the most?
- How often do you spend time on social media daily?
- Do you follow any educational accounts? Which ones?
- What type of learner are you? Visual, auditory, read/write, etc.
- What do you think could increase your interest in Science?

Quantitative Questions

Rate 1 (Strongly Disagree) to 10 (Strongly Agree)

- Science Class
    - I find science class interesting
    - I look forward to my science class
    - Science is difficult to me
    - Practical/lab work in science is interesting
    - I would rather do practical/lab work than attend lectures
- Science Attitude
    - I would like to study science at university
    - I would like to get a job or career in science
    - I believe science and technology is important for society
    - I believe science and technology makes our lives easier

Appendix C: Survey Results from BSAC Interview

Why are you interested in science?

ทำไมคุณถึงสนใจวิทยาศาสตร์

(10 Responses)

วิทยาศาสตร์เป็นสิ่งที่ท้าทาย น่าค้นหา
I find it interesting and I want to become a doctor.
ชอบทำการทดลอง
วิทยาศาสตร์เป็นวิชาที่ศึกษาเกี่ยวกับธรรมชาติ ทั้งในด้านกายภาพและชีวภาพ สามารถนำไปประยุกต์ใช้เพื่อสร้างสรรค์นวัตกรรมที่มีประโยชน์ในอนาคต
I love the idea of shifting reality to my will
It is interesting to learn about things that in our daily lives
เพราะรู้สึกว่าเป็นสิ่งที่สามารถเจอข้อมูลที่updateตลอด และเป็นศาสตร์ที่ใช้เหตุผลและหลักการที่ตรวจสอบและจับต้องได้
Cz science is more reliable than any other things, there’s prove of what have been invented. And there are more things to be create and learn a lot more.
เพราะว่าน่าสนใจค่ะแล้วก็ชอบอยู่ใน lab
Because science is fascinating like how chemical works and stuff

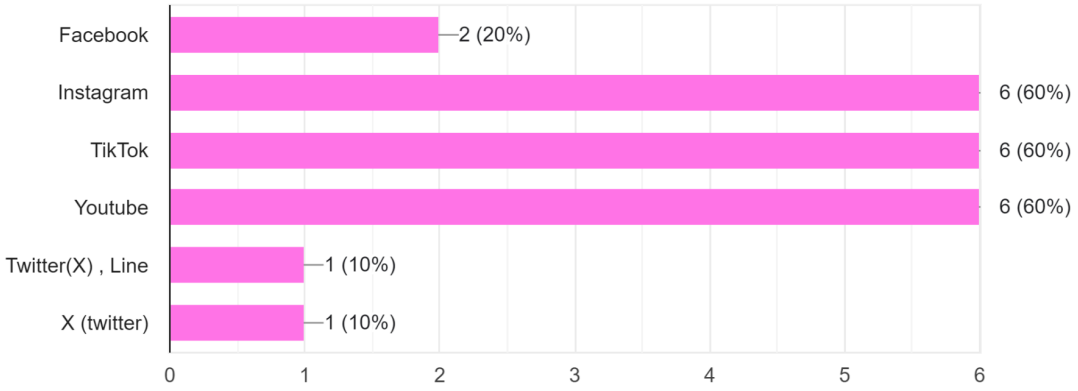
What other subjects are you interested in?

นอกจากวิทยาศาสตร์ คุณสนใจวิชาอะไรอีกบ้าง

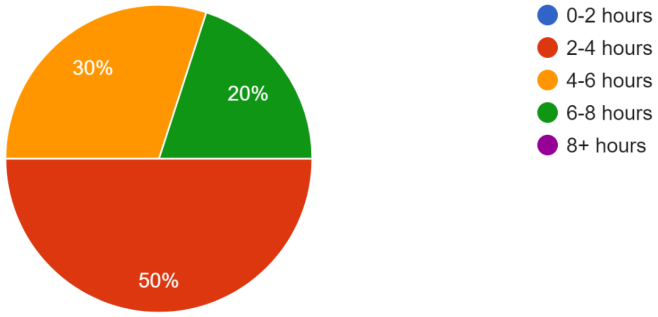
(10 Responses)

ภาษาอังกฤษ
Math
ภาษาอังกฤษ
ประวัติศาสตร์/ภาษา
Music, Artistry
English
ศิลปะ
Math, PE
english , music , other language class
Culinary art, math

If you use social media, which platform do you use the most?
คุณใช้แพลตฟอร์มโซเชียลมีเดียใดมากที่สุด
(10 Responses)



How much time do you spend on social media daily?
คุณใช้โซเชียลมีเดียวันละกี่ชั่วโมง
(10 Responses)



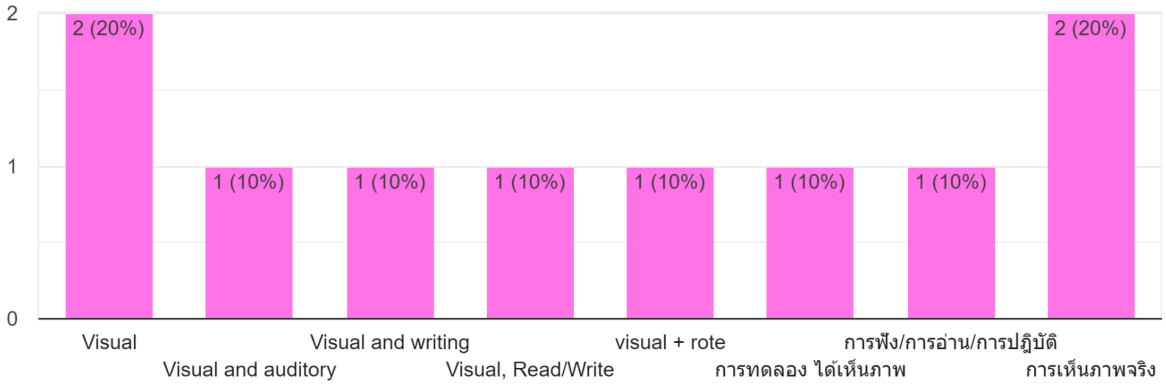
Do you follow any educational social media accounts? Which ones?
คุณติดตามช่อง/เพจที่มีเนื้อหาทางการศึกษาอยู่หรือไม่ ถ้าติดตาม คุณติดตามช่อง/เพจอะไรบ้าง
(10 Responses)

ติดตาม studygram ใน IG แอพลิเคชั่นเตรียมสอบต่างๆ
AmoebaSisters(Youtube), Khan Academy(Youtube)
ติดตาม พี่ลาเต้,เด็กดี Twitter(x)
WiTcast
Nilered, That Chemist, Explosions&Fire, SciShow, Veritasium
Dekd, Aimmuno, NoteworthyMF
T-cas/dek-d/Interbooster
No
ignite
Nilered, Kurzgesagt

What type of learner are you? Visual, auditory, read/write, etc.

คุณมีความถนัดในการเรียนรู้แบบใดมากที่สุด เช่น การเห็นภาพจริง, การฟัง, การอ่าน, อื่นๆ

(10 Responses)



What do you think could increase your interest in science?

มีอะไรบ้างที่จะสามารถทำให้คุณสนใจวิทยาศาสตร์มากขึ้น

(9 Responses)

การทำให้วิทยาศาสตร์ที่ยากเป็นสิ่งที่ง่าย
Onsite activities
ได้ทำการทดลองสิ่งใหม่ๆ
การได้เรียนรู้มากขึ้นเกี่ยวกับความรูและการประยุกต์ใช้ในศาสตร์ที่สนใจ
more lab work ^^
Science news
All the cosmetics stuff makes me want to learn a lot more
teacher teach fun
Link science to daily life like how baking soda help cake become fluffy

Appendix D: Survey Results from Chulalongkorn University Open House

How did you hear about this event?

คุณทราบเรื่อง Chula Open House ได้อย่างไร

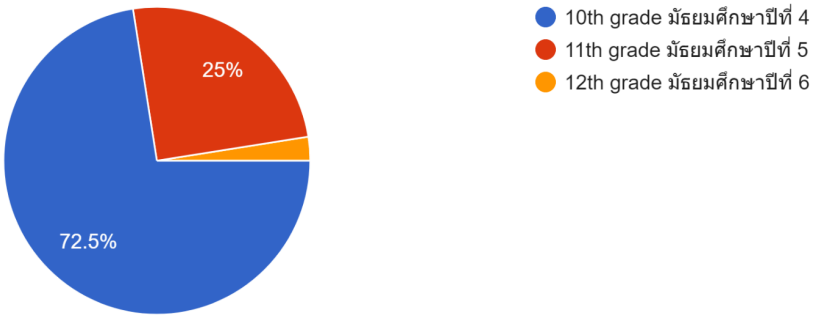
(28 Responses)

ทาง ig ของทาง Chula Open House	ทางโซเชี่ยล
ทราบจากคุณครูแนะแนวที่โรงเรียน	From my friend
จากเพื่อนและครู	เพื่อนชวนมา
ทางโรงเรียนแจ้งข่าวสารให้ทราบ	เพื่อน
ทราบจากทางFacebook	เพื่อน
by social media	เพื่อน
จากเพื่อน	Ig
Ig	เจอเพจ cuopenhouse
ผ่านทางโรงเรียน	Instagram
รู้ผ่านเพื่อน	เพื่อนชวน
จากเพื่อน	ไอจี
เพื่อน อาจารย์ที่จุฬ้า	จากเพื่อนรุ่นพี่และไอจีอพฮจุฬ้า
จากเพื่อร	ในไอจี
Tiktok	การเพราะเชื้อโรค

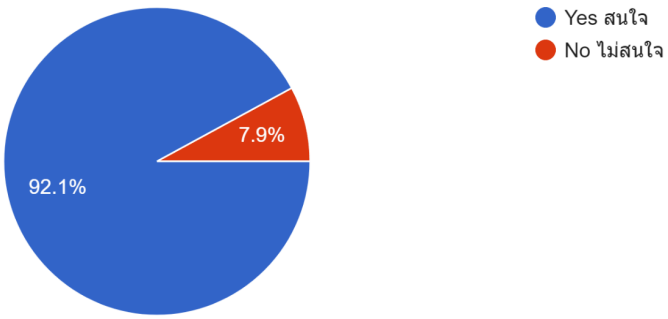
What grade are you in?

ปัจจุบัน คุณศึกษาอยู่ในระดับชั้นใด

(40 Responses)



Are you interested in the Faculty of Science?
คุณสนใจคณะวิทยาศาสตร์หรือไม่
(38 Responses)



Why are you interested/not interested in the Faculty of Science??
ทำไมคุณถึงสนใจ/ไม่สนใจคณะวิทยาศาสตร์
(39 Responses)

สนใจเพราะว่ามีหลักสูตรที่อยากจะเข้าก็คือ วิทยาการคอมพิวเตอร์ และเป็นคณะที่น่าสนใจ	เพราะมีการทดลองที่สนุกและน่าสนใจ
เพราะหนูอยากเข้าคณะวิทยาการคอม เลยสนใจคณะวิทค่ะ แล้วส่วนตัวก็ชอบเรียนวิทอยู่แล้วด้วย เลยทำให้มีความสนใจในคณะนี้ที่เพิ่มขึ้น	หนูชอบวิทยาศาสตร์
อยากจะทดลองทำสิ่งใหม่ๆ	ชอบ
สนใจ เพราะชอบการทดลอง	The facility contain various topics mostly chemistry.
เหมือนเป็นการไขสิ่งต่างๆว่าสิ่งๆนี้เกิดขึเนได้อย่างไร	ที่สนใจเพราะ ภายในชอบเรียน วิทยาศาสตร์
ชอบการทดลองต่างๆ	สนใจวิชาชีววิทยา
เพราะสนใจทางด้านนี้	เพราะว่าชอบ
เพราะ เรียนสายวิทย์สุขภาพ	รู้สึกอยากที่จะทดลองเชื้อและอยากศึกษาเกี่ยวกับเชื้อรา, แบคทีเรีย และอื่นๆ
เพราะว่าชอบชีววิทยา	เป็นสิ่งที่น่าค้นหาเพราะชอบเรื่องสิ่งมีชีวิตและสิ่งแวดล้อม ธรรมชาติ อยากรู้ถึงการมีอยู่ของสิ่งมีชีวิตว่ามาจากไหนและมาได้ยังไง
มีgeology	สนใจเพราะเป็นสิ่งที่เรียนรู้เกี่ยวกับสิ่งรอบตัว
เพราะ ชอบในด้านนี้	สนใจเกี่ยวกับชีววิทยาในการต่อยอดเอาไปศึกษาต่อในระดับปริญญาโท
เพราะ สนใจวิชาเคมีและฟิสิกส์	มีอะไรหลายอย่างที่น่าเรียนรู้
เพราะเป็นคณะที่ได้เรียนเกี่ยวกับวิชาที่ชอบ	สนใจเพราะว่าคณะวิทยาศาสตร์ดูน่าสนุกดี
ชอบการทดลอง	I'm interested in biology
สนใจเพราะเป็นการทดลอง	มีเกี่ยวกับวิชาวิทยาศาสตร์
-	เริ่มสนใจนิดๆแต่มีคณะในใจแล้ว

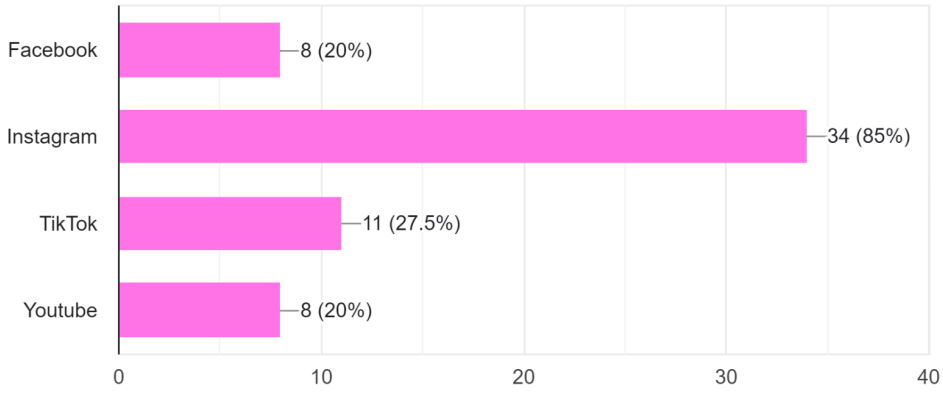
ผมสนุกเวลาที่ได้เรียนเคมี ฟิสิกส์ ชีวะ ได้รู้ ได้ทดลอง ได้ทำโจทย์ เลยสับสนว่าควรไปทางไหนทจึงเริ่มคนหาตัวเอง คณะวิทยาศาสตร์และวิศวกรรมศาสตร์เป็นคณะที่ขึ้นมาในใจครั้งแรก จึงค่อยๆเริ่มหาข้อมูลของสายการเรียน การงาน เส้นทางในอนาคตของสายนั้นๆ	มาเก็บข้อมูลสอบ สอวน.
ตรงสายที่เรียน	สนใจ
เพราะมีความถนัดในวิชานี้	มีการเข้าแล็ป
เคยมา พิพิธภัณฑ์ ก่อนหน้านี้ มีความหลากหลาย	

What other faculties are you interested in?
นอกจากคณะวิทยาศาสตร์ คุณสนใจคณะอะไรอีกบ้าง

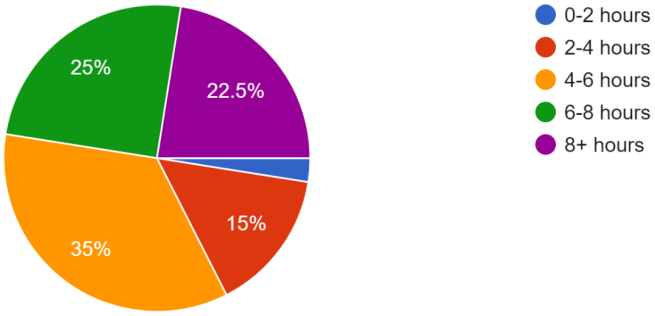
(40 Responses)

คณะเทคโนโลยีสารสนเทศ	คณะแพทย์ศาสตร์	คณะนิเทศศาสตร์	ทันตะ
คณะวิศวะ, ทันตะ, เภสัช	คณะวิศวกรรมศาสตร์	นิติศาสตร์ เภสัช	คณะเภสัชศาสตร์ คณะเทคนิคการแพทย์
สนใจคณะพาณิชศาสตร์และการบัญชี	เภสัชศาสตร์	นิเทศ	สถาปัตย์
เภสัช	เทคนิคการแพทย์	นิเทศศาตร์	คณะแพทยศาสตร์
สถาปัตย์ นิเทศ	คณะนิเท	Psychology	Dent
คณะบัญชี	วิทย์สุขภาพ	Environmental sc และ รัฐศาสตร์	คณะเภสัชศาสตร์
คณะแพทย์ศาสตร์	วิศวกรรมศาสตร์	แพทย์ศาสตร์	เภสัช
คณะแพทย์ คณะทันตะ	จิตวิทยา	วิศวกรรมศาสตร์	แพทย์
คณะแพทยศาสตร์	คณะวิศวกรรมศาสตร์	คณะอักษรศาสตร์	คณะแพทย์
วิศวกรรมศาสตร์	วิศวะ	คณะจิตวิทยา(JIPP)	ไม่มี

If you use social media, which platform do you use the most?
คุณใช้แพลตฟอร์มโซเชียลมีเดียใดมากที่สุด
(40 Responses)



How much time do you spend on social media daily?
คุณใช้โซเชียลมีเดียวันละกี่ชั่วโมง
(40 Responses)



Do you follow any educational social media accounts? Which ones?
คุณติดตามช่อง/เพจที่มีเนื้อหาทางการศึกษาอยู่หรือไม่ ถ้าติดตาม คุณติดตามช่อง/เพจอะไรบ้าง
(32 Responses)

ติดตาม เช่น Camphub Dekdtcas tcaster	-
ติดตาม ติดตามเพจ camphub dekdee	ไม่ได้ติดตาม
ไม่	Cuopenhouse
-	ฟาโรส หมอตังเวรชันสูตร
Camphub	-
ไม่ได้ติดตามเลย	No
ทางติ๊กตอก	-

ไอจี	ไม่ได้ติดตาม
ไม่ได้ติดตาม	ติดตามช่องเกี่ยวกับภาษาและพี่ที่เล่าเรื่องการเรียนแพทย์ของเขาและเคสคนไข้ที่น่าสนใจ
มิตรเอิร์ท	ติดตาม เพจ hatum camphup etc.
ไม่ได้ติดตาม	hatum.port / camphub
ติดตาม ช่องทางเพจfacebook	ติดตามไอจี hatum,camphub
bioislike	ติดตามเพจจุฬาลงกรณ์
ไม่	Yes Krufai easy bio
ติดตามจุฬา	ไม่
Ig facebook	เพจmicro เพจจุฬา

What type of learner are you? Visual, auditory, read/write, etc.
คุณมีความถนัดในการเรียนรู้แบบใดมากที่สุด เช่น การเห็นภาพจริง, การฟัง, การอ่าน, อื่นๆ

(39 Responses)

การฟังละจดตาม	การเห็นภาพจริง	การฟัง	เห็นภาพจริง
การเห็นภาพจริง	การเห็นภาพจริง	การฟัง การอ่าน	การเห็นภาพจริง
การอ่าน การทดลองทำ การเห็นภาพจริง	การอ่าน การฟัง	พูด	ฟังและเห็นตัวอย่าง
การฟัง และ การปฏิบัติ	การฟัง	การฟัง	การอ่านและการฟัง
การเห็นภาพ วาดรูป	การฟัง การอ่าน	Read and write	Visual
การเห็นภาพจริง , การอ่าน	จำ	การฟัง	การฟัง
การอ่าน	การลงมือทำ การฟัง การเห็นภาพ	การเห็นภาพจริง ได้ลงมือทำ	ทุกอย่างคับ
การเห็นภาพจริง	การเห็นภาพจริง	การเห็นภาพจริง การฟัง	การฟัง เห็นภาพ ทดลองต่างๆ
การปฏิบัติจริงง	การเห็นภาพจริง	การเห็นภาพจริง	การเห็นภาพจริง การฟัง
ฟัง	อ่าน-ฟัง	การเห็นภาพจริงและอ่าน	

What do you think could increase your interest in science?
มีอะไรบ้างที่จะสามารถทำให้คุณสนใจวิทยาศาสตร์มากขึ้น

(34 Responses)

การทดลองที่น่าสนใจและแปลกใหม่	การเรียนรู้
การได้ลงมือปฏิบัติกิจกรรมทดลองค่ะ	การทดลอง
การทดลองที่น่าสนใจ	ร่างกายมนุษย์

วิทยาศาสตร์ทางทะเล	Physical activities including experiments
การทดลอง	เนื้อหา ที่เป็นประโยชน์
ทดลอง	การเรียน การทำงาน
การรีวิว	พืช,การเพาะเชื้อรา,การทำยา และกราสตาฟสัตว์
การเข้าค่าย	การได้เรียนรู้เรื่องที่ยังไม่เคยเรียนและพบเจอในชีวิตประจำวัน
การค้นพบใหม่ๆทางธรณีวิทยา	การทดลอง lab
ชอบเกี่ยวกัยชีวะ	การทำแล็ป
การทดลอง	การส่องเซลล์
การได้ทำแลป ได้เห็นทฤษฎีที่เรียนของจริง	การที่สอนให้สนุก
การพิสูจน์หลักการต่างๆ	Went to oph
ทดลอง	การเข้า microlab
ความรู้ใหม่ๆที่หน้าตื่นเต้น การทดลองทำเรื่องที่ไม่ซ้ำจากตำรา การนำไปประยุกกับสิ่งรอบตัวได้ ทำขึ้นเองได้ ทดลองเองได้	ความรู้
ธรรมชาติ	สาขาจุลชีวะวิทยา
กิจกรรมต่างๆของทางคณะ	การทดลอง และผลของการทดลอง

Appendix E: Survey Results from MIT Nobel Laureate Lecture (Quantum Dots: Discovery & Synthesis)

How did you hear about this event?

คุณทราบเรื่อง MIT Lecture ได้อย่างไร

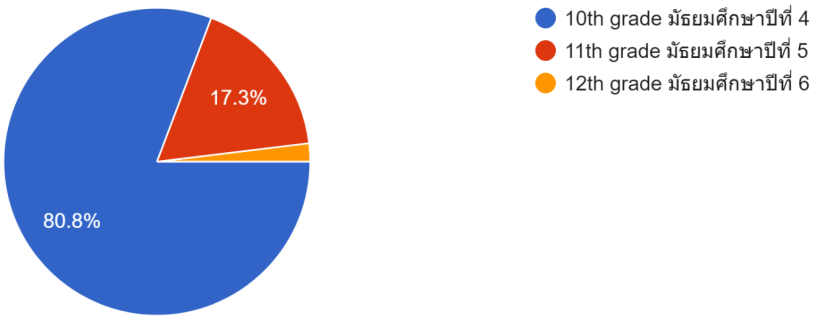
(36 Responses)

ครูที่โรงเรียนเชิญชวนมา	จากโรงเรียน	ครูประจำวิชา	โรงเรียนประสาน
From my friends	จากทางโรงเรียน	โรงเรียนประชาสัมพันธ์	พี่
From a friend	My mom tell me	อาจารย์ที่โรงเรียน	โรงเรียน
มีพี่บอกให้บอกให้ทำลิ้งครับ	จากครูประจำวิชา	From my school	จากอาจารย์ที่ปรึกษา
ได้ยินจากพี่ที่รู้จัก	ครูแนะนำ	โรงเรียนประชาสัมพันธ์	จุฬ้า
เพื่อน	My mom tell	Social media	ครู
อาจารย์	จากอาจารย์	School	มาฟังอบรมที่จุฬ้า
อาจารย์ที่โรงเรียน	อาจารย์ที่รร.แนะนำและเชิญชวน	Via mu school	รู้เรื่องเทคโนโลยีใหม่มากขึ้น
โรงเรียนเชิญชวน	ผ่านอาจารย์ภายในโรงเรียน	โรงเรียนประชาสัมพันธ์	It about electron

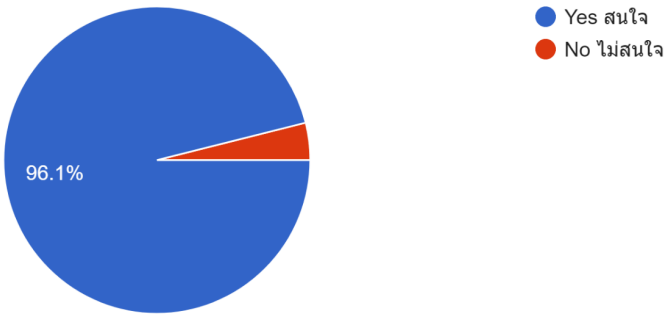
What grade are you in?

ปัจจุบัน คุณศึกษาอยู่ในระดับชั้นใด

(52 Responses)



Are you interested in the Faculty of Science?
คุณสนใจคณะวิทยาศาสตร์หรือไม่
(51 Responses)



Why are you interested/not interested in the Faculty of Science??
ทำไมคุณถึงสนใจ/ไม่สนใจคณะวิทยาศาสตร์
(50 Responses)

To understand nature of universe.	มีเรื่องราวน่าสนใจให้ศึกษา
Science has always been a favorite subject of mine	เพราะเป็นสิ่งใกล้ตัวเรา
Because i find it amusing to be able to find out things that i dont know	เพราะวิทยาศาสตร์อธิบายสิ่งที่เกิดขึ้นในชีวิตประจำวันได้
Because I feel like it's an fundamental subject and is essential for human to advance further	It explains how things work in my daily life
ชอบอย่างอื่นมากกว่า	Bc its fun
มีความชอบเกี่ยวกับสัตว์ทุกตัว🤞	วิทยาศาสตร์คือสิ่งที่สามารถอธิบายปรากฏการณ์ต่างๆบนโลกได้โดยมีเหตุผลที่ชัดเจนอย่างแท้จริง ผ่านการทดสอบและทดลองจนได้ข้อสรุป ไม่มีการคาดเดาไปเอง
รู้สึกว่ามันเป็นสิ่งที่เราไม่รู้แล้วเราต้องมาหาคำตอบด้วยการค้นคว้า	Because I like how math and logic is connected all in physic chemistry biology technology and almost everything.
ชอบความแปลกและความที่เราไม่รู้ว่าจะเจออะไรอีก	because it is interesting and has many uses in real life
ต้องการนำความรู้ไปต่อยอดเพื่อเป็นนักวิทยาศาสตร์ระดับโลก	Because science explains the beings of the universe.
เพราะวิทยาศาสตร์เป็นสิ่งที่สามารถพิสูจน์ได้	Because i love biology and microbiology and it interest me
เพราะวิทยาศาสตร์ คือความจริงเพราะผ่านการพิสูจน์และทดลองมาแล้ว	ชอบการพิสูจน์และการอธิบานปรากฏการณ์
เพราะวิทยาศาสตร์เป็นสิ่งที่น่าค้นหาและน่าเรียนรู้	โรงเรียนมีการส่งเสริมบ่มเพาะให้นักเรียนเรียนรู้ทางด้านวิทยาศาสตร์ + มีเพื่อนที่ชื่นชอบและสนใจทางด้านวิทยศาสตร์เหมือนกัน

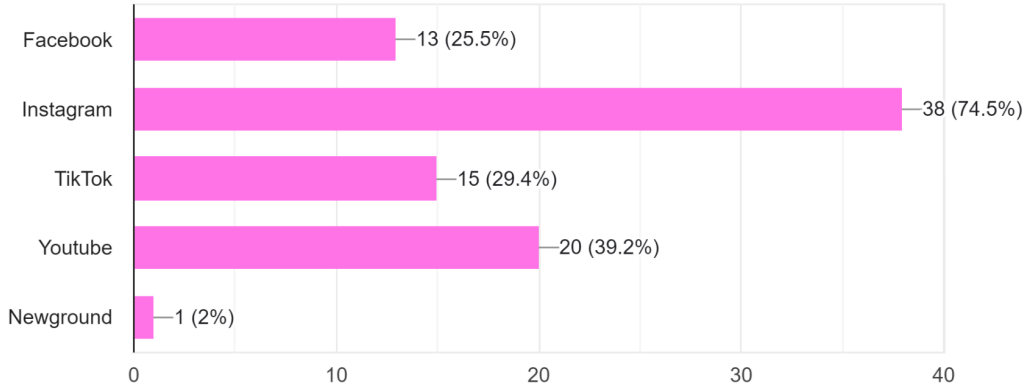
มีความเกี่ยวข้องกับการพัฒนาเทคโนโลยีต่างๆและสามารถอธิบายปรากฏการณ์ต่างๆได้	ลงลึกในสิ่งที่อยากรู้
เพราะมีความน่าสนใจ	เรียน
ชอบในการอธิบายเหตุผลต่างๆที่เกิดขึ้น	ความก้าวหน้าของเทคโนโลยี
Sometimes it's look interesting when learning some new knowledge.	สนใจ
เชื่อมเหล็ก ชุบเหล็ก หลอมเหล็ก	มันได้เรียนรู้สิ่งไหม่ๆ
เพราะวิทยาศาสตร์เป็นวิชาที่พิสูจน์สิ่งต่างๆรอบตัวเรา เป็นวิชาที่ไร้ขีดจำกัดในการเรียนรู้	ไม่ถนัด
science allows me to discover new things	ไม่ถนัดเรื่องการจำ
มีอะไรให้น่าศึกษาอยู่ตลอดเวลา	น่าเรียนรู้
เพราะเป็นสิ่งที่มหัศจรรย์	สนุก
it is fun and i learn a lot of new things	เปนสิ่งที่น่าค้นหาเพราะหด้เรียนรู้สิ่งใหม่ๆ
วิทยาศาสตร์ทำให้เข้าใจความจริงของโลกมากขึ้น	มีความสนุกและสามารถทดลองผิดถูกได้
วิทยาศาสตร์เป็นภาคแขนงที่มีความเป็นไปได้อันไร้ขีดจำกัดเมื่อได้ลองเรียนรู้ลองทำความเข้าใจ ทำให้เริ่มเห็นถึงการอธิบายสิ่งต่างๆ จนเกิดสนใจขึ้นมา	น่าค้นหา
เป็นเรื่องที่คิดว่าน่าสนใจเพราะมีการค้นพบใหม่ๆเรื่อยๆและสนใจมาตั้งแต่เด็ก	Science good

What other subjects are you interested in?
นอกจากวิทยาศาสตร์ คุณสนใจวิชาอะไรอีกบ้าง
(51 Responses)

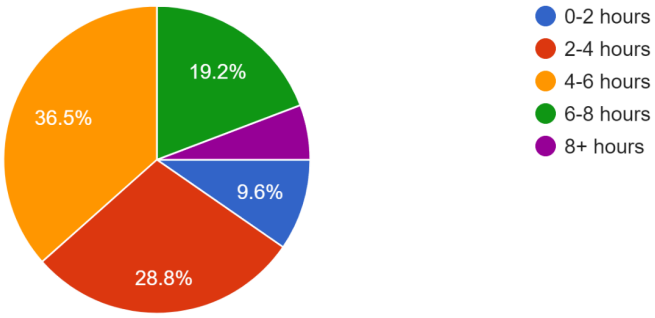
Philosophy and writing	อังกฤษ	maths	Computer science and technology	คณิตศาสตร์
Math	ภาษาอังกฤษ	คณิศาสตร์และศิลปะ	philosophy and literature	ศิลปะ
maths	อังกฤษ	คณิศาสตร์ ภาษาศาตร์	Drama	ศิลปะ
Physical education	คณิตศาสตร์	ประวัติศาสตร์ คณิตศาสตร์	Drama	คณิตศาสตร์
ศิลปะ	Maths	คณิตศาสตร์	ภาษาอังกฤษ	คณิต
คอมและไอที	ฟิสิห	คอมพิวเตอร์	ประวัติศาสตร์ , นิติศาสตร์	Anatomy
ภาษาจีน	บัณชีและการเงิน	ศิลปะ คณิตศาสตร์	คณิต	Computer
เคมี	business	English	เรียน	ศิลปะ คอม
คณิตศาสตร์	คณิต	Physics	computer sci	ศิลปะ
คณิตศาสตร์	ดนตรี	ศิลปะ, ภาษาอังกฤษ	คณิต,ศิลปะ	Biology

คณิต				

If you use social media, which platform do you use the most?
คุณใช้แพลตฟอร์มโซเชียลมีเดียใดมากที่สุด
(51 Responses)



How much time do you spend on social media daily?
คุณใช้โซเชียลมีเดียวันละกี่ชั่วโมง
(52 Responses)



Do you follow any educational social media accounts? Which ones?
คุณติดตามช่อง/เพจที่มีเนื้อหาทางการศึกษาอยู่หรือไม่ ถ้าติดตาม คุณติดตามช่อง/เพจอะไรบ้าง
(32 Responses)

Facebook	Yuzu tutor /ฟิสิกส์โกเอก	ติดตาม ช่อง point of view , Say sci ,ชีวิตสดใส	มี SteveMould(YT,IG), Vsauce(YT)
Yes, mark rober , Nilered	ไม่ติดตาม	ไม่ได้ติดตาม	Pūd,saysci
mainly review channels on youtube like the organic chemistry	No	-	ไม่ได้ติดตาม

teacher			
Bentist, Nilered, etc.	ไม่	-	Saysci
ไม่	Tiktok	ไม่	SaySci
camphub	mark rober	Yes , Vsauce , Veritasium	ไม่
ติดตามค่ะ เพราะอยากได้ความรู้มาใช้ในการสอบ	ไม่มี	Yes. I follow university accounts.	จารย์supk
ไม่	ช่อง point of view	Yes. I follow A-level accounts.	Markrobber
ไม่	mark rober	Universities accounts	Bcc
ติดตาม dentchulaopenhouse	Pūd,saysci	Wendover Productions, 3Blue1Brown	ติดตามเพจเรียนต่อไหนดี
TikTok (จำชื่อaccountไม่ได้)	-	It’s aimunoglobulin , krupbas , etc.	Ig
Idealphysic	-	ไม่มี	
Yuzu tutor/ฟิสิกส์โกเอก	ไม่	เรียน	

What type of learner are you? Visual, auditory, read/write, etc.
คุณมีความถนัดในการเรียนรู้แบบใดมากที่สุด เช่น การเห็นภาพจริง, การฟัง, การอ่าน, อื่นๆ

(50 Responses)

Write and read	การเห็นภาพจริง การฟัง	การเห็นภาพจริง	การเห็นภาพจริง, การฟัง	ภาพจริง
Visual	การเห็นภาพจริง	auditory	Visual	การอ่าน
I am a read and write learner	การเห็นภาพจริง	การเห็นภาพจริง	visual and auditory	การเห็นภาพจริง
visual and auditory	การเห็นภาพจริง	การเห็นภาพจริง การฟังแนวคิด การใช้เวลาทำความเข้าใจหลังได้รับข้อมูล	Auditory	การเห็นภาพจริง
การเห็นภาพจริง	การอ่าน การจำ	การเห็นภาพจริงหรือการได้ทำการทดลองจริง	Visual and read	การคำนวน
ถนัดการเห็นภาพจริง+การฟัง	Visual and read	การฟัง	การเห็นภาพจริง จากการทดลอง หรือสื่อการสอน	เห็นภาพจริง
การเห็นภาพจริง	ฟัง เห็นภาพ	การฝึกทำจริง	การเห็นภาพจริง	ฟัง
การฟัง	เห็นภาพและฟัง	การฟัง การอ่าน	การเห็นภาพจริง	การวาด

การเห็นภาพจริง	visual	Visual	ป	การเห็นภาพจริง
การฟัง	การเห็นภาพจริง	Visual	ฟัง	I

What do you think could increase your interest in science?
มีอะไรบ้างที่จะสามารถทำให้คุณสนใจวิทยาศาสตร์มากขึ้น
(50 Responses)

Creative	ได้เรียนรู้เกี่ยวกับสิ่งที่เราสนใจ
Experiments and Great explanations from teachers help me best	การที่เราสามารถสำรวจท้องทะเลได้มากกว่า 5 % หรือสำรวจพื้นที่นอกโลกได้เยอะขึ้น
probably the job i can get with it	การนำวิทยาศาสตร์มาประยุกต์ใช้ในชีวิตประจำวัน
Possibly payment and new discovery	Seeing it in action
-	Read more books
พวกสัตวต่างๆ🤞	สื่อออนไลน์
การทดลอง	Technology and how fast it improves.
การทดลอง	real life demonstrations of its uses, scholarships
ความรู้ทางฟิสิกส์ความจริงที่อยู่รอบตัวเราแต่ยังไม่มีใครค้นพบ	Scholarships
การเกิดของจักรวาล	Scholarship
ฟิสิกส์ และอยากเข้าคณะวิศวกรรม	เพื่อน , สภาพแวดล้อม , etc.
การทดลองหรือสมมุติฐานที่น่าสนใจ	สิ่งที่ค้นพบใหม่ๆ
การฟังจากผู่ที่มีความรู้ทางด้านวิทยาศาสตร์	แ
การฟังบรรยายจากผู้มีความรู้วิทยาศาสตร์	science breakthrough
infographic	การทำแล็ป
Some fun activities	สิ่งไหม่ๆ
เงินเดือนสูงๆ	การทำแลป
เนื้อหาที่น่าสนใจ	การทำการทดลอง
relationship of science to business	เกม
การทดลอง	การที่ได้องอะไรใหม่ๆ
การค้นพบดาวดวงใหม่	-
interesting things and how it can affect my life	สัมมนา
การคำนวณ	การทดลอง
สิ่งใหม่ๆที่น่าสนใจและเข้าถึงได้	Read more
การได้ทำการทดลองจริง	

Appendix F: Survey Results from Chem See You Camp

How did you hear about this event?

คุณทราบเรื่อง CHEM See You Camp ได้อย่างไร

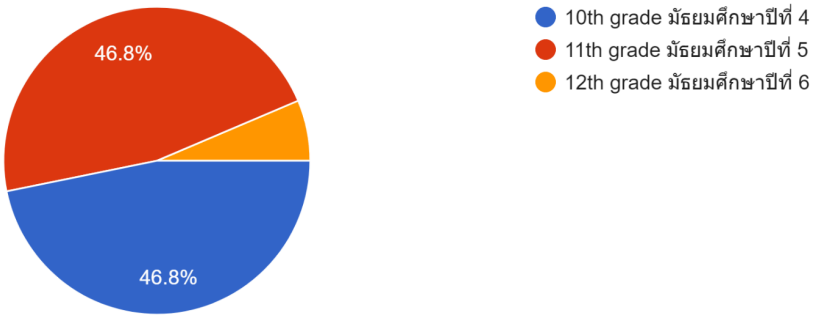
(32 Responses)

Bsac website	friends	งานopen house ของคณะวิทย์	เว็ปภาควิชาเคมี และคณูที่ปีกษาแนะแนว
จากเพื่อนๆ	ig	Facebook	line
จากเพื่อน	หาคณะที่สนใจผ่านเน็ดแล้วเจอ	กิจกรรมโอเพ่นเฮาส์	ทราบจากอินเทอร์เน็ต
เพื่อน	พี่แนะนำ	From announcement in the Instagram.	พี่ๆสตาฟแนะนำตอนมา openhouse CUค่ะ
Facebook	จากการแนะนำของเพื่อน	ประกาศทางFacebook	Ig
fb	จากไอจีchemchula	friends	Open house คณะวิทย์
จากเฟสบุ๊คและเพื่อน	รู้จักตอนมางานโอเพ็นเอ้าส์คณะวิทยาศาสตร์	Chula Science open house	ข้อมูลเกี่ยวกับคณะ
ที่เรียนพิเศษ	Openhouse คณะวิทยาศาสตร์	ทราบจากเพจของ Chem Chula	เพื่อนแชร์ให้

What grade are you in?

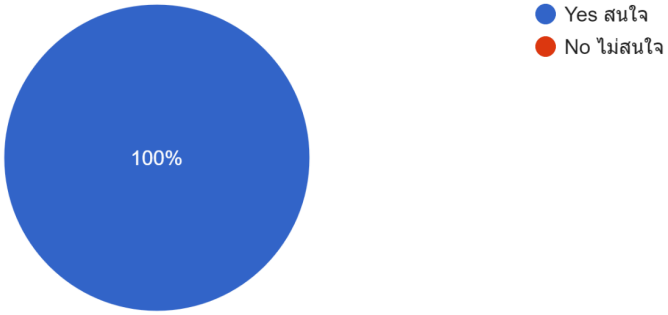
ปัจจุบัน คุณศึกษาอยู่ในระดับชั้นใด

(47 Responses)



Are you interested in the Faculty of Science?
คุณสนใจคณะวิทยาศาสตร์หรือไม่

(46 Responses)



Why are you interested/not interested in the Faculty of Science??
ทำไมคุณถึงสนใจ/ไม่สนใจคณะวิทยาศาสตร์

(44 Responses)

สนใจเพราะคิดว่าการทำแลปสนุกดีค่ะ	It is fun and has many topics to explore.
สนใจเพราะ วิทยาศาสตร์อยู่รอบตัวเรา	เพราะว่าเทคโนโลยีเปลี่ยนโลกส่วนใหญ่มาจากวิทยาศาสตร์ตั้งแต่ยุคปฏิวัติอุตสาหกรรม
เพราะวิทยาศาสตร์ต้องใช้ในการศึกษาต่อ	Because it is very significant in practical life.
วิทยาศาสตรอยู่รอบตัวเรา	หนูชอบในทดลอง และ การประดิษฐ์ จึงสนใจวิทยาศาสตร์
It's like an expedition that I can learn everything from it while exploring	สนุกในการเรียนรู้
something I can't explain	รู้สึกว่าจะได้เรียนรู้การทำงานของหลายๆอย่างรอบตัว
เป็นสิ่งที่อธิบายได้ในธรรมชาติ	Its starting with not liking it at first which requires quite a lot of efforts to pass every subject, however the further I learn I start to like it more.
ชอบเรียนวิชานี้	สนุกที่ได้ความรู้ และได้ทำ
ชื่นชอบเกี่ยวกับวิทยาศาสตร์	อยากเรียนรู้
สนใจเพราะ เป็นวิชาที่relateกับพื้นฐานต่างๆในโลก	วิทยาศาสตร์เป็นสิ่งที่อยู่ในชีวิตประจำวันรอบตัวเราและสนใจในเคมีเป็นพิเศษเพราะมีการทดลองปฏิบัติจริงเพื่อให้ได้ผลสรุปที่แท้จริง
วิทยาศาสตร์สามารถอธิบายสิ่งต่างๆรอบตัวได้	ชอบวิชาเคมีสนใจในอาชีพที่ต้องใช้วิทยาศาตร์
เพราะว่าช่วยตอบปัญหาที่สงสัยได้ค่ะ	เป็นศาสตร์ที่ให้ความรู้ใหม่ๆรวมถึงสามารถต่อยอดได้
สนใจแค่เฉพาะอย่างเดียวคือ cosmetic science	เพราะวิทยาศาสตร์อธิบายความเป็นจริง
สนใจเพราะเป็นสาขาที่มุ่งเน้นหาคำาตอบในสิ่งที่เรายังไม่ทราบ	I am interested in science because I find it fun and relatable to the real world.
เป็นวิชาที่หลากหลายและเกี่ยวข้องกับการประกอบอาชีพในอนาคต	ชอบการทดลอง,ทำlabค่ะ
เพราะมันคือจุดเริ่มต้นของทุกอย่างและสนุก	ทุกอย่างรอบตัวเกี่ยวกับวิทยาศาสตร์ ,เป็นศาสตร์ที่สนุก

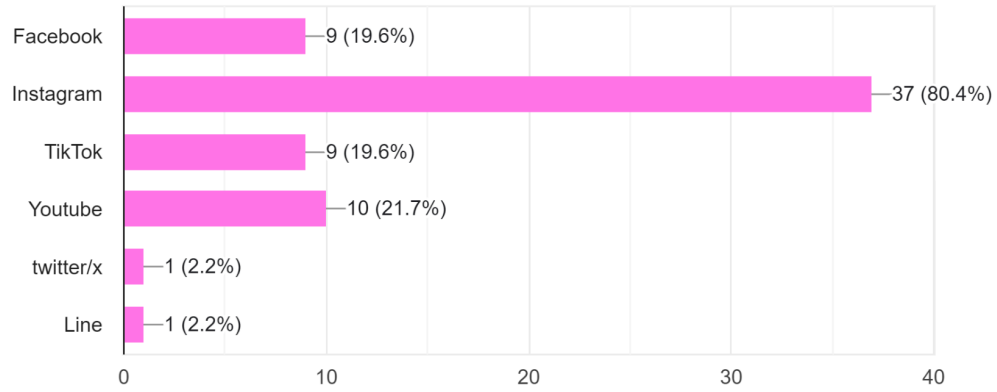
เป็นวิบาที่ศึกษาเกี่ยวกับธรรมชาติ หรือสิ่งต่างๆที่อยู่รอบตัว	เป็นวิชาที่ใช้ในชีวิตประจำวัน มีความรู้พัฒนา
เพราะสามารถตอบปัญหาและอธิบายเรื่องต่างๆได้	ปกติวิทยศาสตร์เป็นพื้นฐานของชีวิตประจำวัน
เพราะผมลองไปวิชาอื่นแล้วมันไม่ถูกฉโหลกครับเหมือนจะใช่แต่ก็ไม่ใช่เลยกลับมาดูวิทยาศาสตร์เลยคิดว่าใช่ครับ	I have always been interested in science whether it involves subjects like physics or biology
เรียนสายวิทย์คณิตมา แล้วรู้สึกชอบ	Firstly, science is a way to understanding how things evolve around us. It's a way to understand how things work in the past and continuing to discover new things on earth. Especially chemistry, the subject itself inspires me accomplish things around this field 🧪👩‍🔬
I find it interesting as well as challenging.	สนุกดีค้าบ
เพราะเป็นศาสตร์ที่สามารถอธิบายเหตุการณ์หรือปรากฏการณ์ต่างๆที่เกิดขึ้นได้ละเอียดปละคลอบคลุม	ชอบการทดลอง แก้ปัญหาโดยใช้หลักทางวิทยาศาสตร์

What other subjects are you interested in?
นอกจากวิทยาศาสตร์ คุณสนใจวิชาอะไรอีกบ้าง

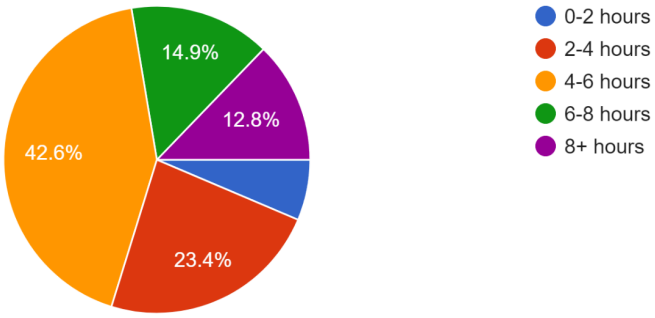
(45 Responses)

Biology, Chinese, and Art	คณิตศาสตร์	ดนตรีสากล
ภาษาอังกฤษ	คณิตศาสตร์	ศิลปะ
คณิต อังกฤษ	History	คณิตศาสตร์ ศิลปะ
คณิตศาสตร์	คณิตศาสตร์ และ ภาษา	คณิตศาสตร์ เต้น
Political science	คณิตครับ	คณิตศาสตร์ จิตวิทยา ผลึกศาสตร์ ปรัชญาสังคม
math	ภาษาอังกฤษ	ไม่มี
ดนตรี	English	Math
ศิลปะ	ภาษาอังกฤษ	วิชาคณิตศาสตร์
คณิตศาสตร์	Mathematics	ภาษาอังกฤษ จีน
ภาษาจีน	คณิตศาสตร์	ดนตรี
คณิต	English	Art&desigh
คณิตศาสตร์	คณะวิศวกรรมศาสตร์	Math
คณิตศาสตร์	คณิตศาสตร์	Music, Mandarin language, Computer Science
Art	history	คณิคศาสตร์
สนใจในวิชาภาษาศาสตร์	Business	สังคม ภูมิศาสตร์

If you use social media, which platform do you use the most?
คุณใช้แพลตฟอร์มโซเชียลมีเดียใดมากที่สุด
(46 Responses)



How much time do you spend on social media daily?
คุณใช้โซเชียลมีเดียวันละกี่ชั่วโมง
(47 Responses)



Do you follow any educational social media accounts? Which ones?
คุณติดตามช่อง/เพจที่มีเนื้อหาทางการศึกษาอยู่หรือไม่ ถ้าติดตาม คุณติดตามช่อง/เพจอะไรบ้าง
(42 Responses)

No	ติดตาม	-
มี easybio	ไม่ได้ติดตาม	ติดตามช่อง เกี่ยวกับการเรียน แนะแนว เกม
มี เพจbcn	yes พูดposcast / 8 minist history	ไม่ได้ติดตาม
มีค่ะ easybio	-	The organic chemistry tutor, Crashcourse
Yes : Kru P'Bas	ครูดิวครับ ครูโอ๋โอพลัส ออนดิมาน	ติดตาม เช่น สอวน. Sut เป็นต้น
IPST, ฟิสิกส์จารย์ปิยะพงศ์, p'max tutor	hatumport , cambridge	Pken official
คนช่างสงสัย	-	I don’t know

Dekd	ครูพี่แอน, camphub, hatum_port	aimmuno,เพจสอนอังกฤษตามไอจี
เพจคณะวิทยาศาสตร์ จุฬ้า	No	Camphub
ตีดตามเพราะอาจจะมีค่ายหรือการแข่งขัน	aimmuno , 9arm , say sci	-
ไม่ได้ติดตาม	Dekdee.con	Mark rober , Nilered , kurzgesagt
aimmuno smartmathpro chemchula	Chula mooc	I do. I mostly follow educational YouTube accounts for instance English with Lucy, Cognito, Organic Chemistry, Action Lab Shorts, etc.
No a	เพจของมหาลัยจุฬ้าฯ มหิดล คณะวิทยาศาสตร์ และเพจเกี่ยวกับฟิสิกส์ เคมีชีวะ	ติดตามทีกูรู
ติดตามบ้าง ไม่แน่ใจจว่ามีเพจอะไรบ้าง	-	ติดตาม 9 arm และอื่นๆ

What type of learner are you? Visual, auditory, read/write, etc.
คุณมีความถนัดในการเรียนรู้แบบใดมากที่สุด เช่น การเห็นภาพจริง, การฟัง, การอ่าน, อื่นๆ

(43 Responses)

เห็นภาพจริงและฟัง	การเห็นภาพจริง	การอ่าน การฟัง การปฏิบัติ
อ่าน	การฟัง	การฟังและการเห็นภาพจริง
การฟังแล้วจด	สัมผัสจากประสบการณ์จริง	การอ่าน การฟัง
การเห็นภาพ	การเห็นภาพจริงและฟัง	อ่าน ฟัง เขียน ลงมือทำ
การฟัง	เห็นภาพจริงและจดบันทึกครับ	การฟัง
attended to class	การอ่าน การเขียน	Visual and auditory
การเห็นภาพจริง	Visual learner	ฟัง อ่าน
การพูด	การเห็นภาพจริง การดู และลงมือทำ	การเห็นภาพจริง
การฟังและการอ่าน	Visual	Listening
การเห็นภาพจริง	การเห็นภาพจริง	Visual
ฟัง	Reading and listening.	All. It depends on what subject I'm studying.
การฟัง การเห็นภาพจริง	การลงมือปฏิบัติ	ฟัง ภาพจริง
การเห็นภาพจริง	การเห็นภาพจริง และทำความเข้าใจ	การเห็นภาพจริง และทดลอง
Visual	การฟัง การเห็นภาพจริง	

การลงมือทำ	Auditory, visual	

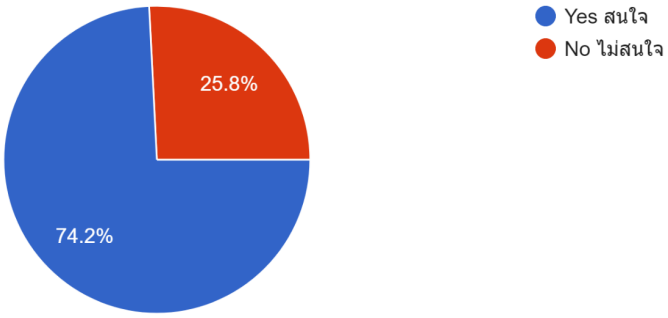
What do you think could increase your interest in science?
มีอะไรบ้างที่จะสามารถทำให้คุณสนใจวิทยาศาสตร์มากขึ้น

(43 Responses)

Experiencing in lab and having workshops	เกม สื่อการเรียน
สัตว์โลก	Interesting experiment topic
ได้ทำกิจกรรมเกี่ยวกับวิทย์	ความท้าทายในรูปแบบต่างๆ และคำถามที่สงสัย
ทำการทดลอง	My grade in school
Research	สิ่งประด งานวิจัยต่างๆ
competitive	เรื่องน่ารู้เกี่ยวกับสิ่งใหม่ๆ การพิสูจน์ความจริงที่มนุษย์ยัง
การเรียนรู้	เวลาเจออะไรที่มันไม่มีคำตอบแน่ชัด หรือเกิดปรากฏการณ์อะไรแปลกๆ
การทดลอง	Hands on activities
วิทยาศาสตร์พิสูจน์ได้	ขอมูลการศึกษาต่าง ๆ การลงมือปฏิบัติและคนแนะนำ
การทดลอง	การสามารถตอบคำถามทฤษฎีที่เป็นปริศนาได้
มีสอบเข้ามาใกล้ๆค_คภคภค	Ingredients ในเครื่องสำอางค์
เรื่องราวใหม่ๆ	โครงงานวิทยาศาสตร์
การทำแลป	หลักการและเหตุผล
Exprerince more about science in our daily life.	Hands on activities
คำถามที่ถูกตั้งมากขึ้น	การเรียนรู้สิ่งใหม่ๆ มีสิ่งใหม่ๆ
การสร้างแรงบันดาลใจ การศึกษาเนื้อหาที่สนใจ	นวัตกรรม
การทดลอง	Reading maybe
ดูวิดีโอสรุปจากยูทูป	Experiments and real life uses of that knowledge claimed
การทดลอง การเจอสถานะการณ์จริง	Seeing seniors at my school attending STEMs related subjects and accomplishing science activities both in school and outside school increase my motivation and confidence to be like them. My role models ❤️
การทดลองครับ ปฏิบัติ	เคมี
การเรียนพิเศษ ทำแลป เข้าค่ายที่เกี่ยวกับวิทยาศาสตร์	เคมีกับความงาม
Broader range of free material	

Appendix G: Survey Results from General Questionnaire

Are you interested in Science?
คุณสนใจวิทยาศาสตร์หรือไม่
(31 Responses)



Why are you interested/not interested in science?
ทำไมคุณถึงสนใจ/ไม่สนใจวิทยาศาสตร์
(31 Responses)

น่าเบื่อมาก	I only really like computer science due to wanting to be working as something related to programming.
Physics Chemistry Astronomy Space	It is interesting to know how our world works.
It's useful for the job I want in the future	Because I can understand the principle
Because it's fun	I don't like science because it difficult for me
Yes because I like astronomy and biology	Because of discovery.
I like space and stars and moon	Because it needs very much participation on understanding the theory, which makes me disappointed of my self when I don't get it, and see myself struggling on it.
I don't mind it ... But I do like biology	Because it's complicated
i'm interested about how certain things work	Because its fun and I'm looking forward to choose a major related to science
I like science because it's interesting it teaches you about studies of life and the world and it's pretty interesting learning about new things	I find science class confusing. I'm interested in learning more my body and how it works but I feel like we don't get enough of that in science class. Most of the time, I get those information from YouTube. There are a lot of research that have been done that have not been excepted in the mainstream medicine.
I like experiment	เพราะมีคำถามมากมายเกี่ยวกับสิ่งมีชีวิตหรือหลักการต่าง ๆ ของทุกอย่างบนโลก และอยากศึกษาหาคำตอบให้ได้
I'm interested in science because is based on facts and how stuff works in our world basically	เพราะวิทยาศาตร์มีความน่าสนใจ เนื้อหามันสอดคล้องกัน พอเรียนไปเรื่อย ๆ ก็ยิ่งสนุก

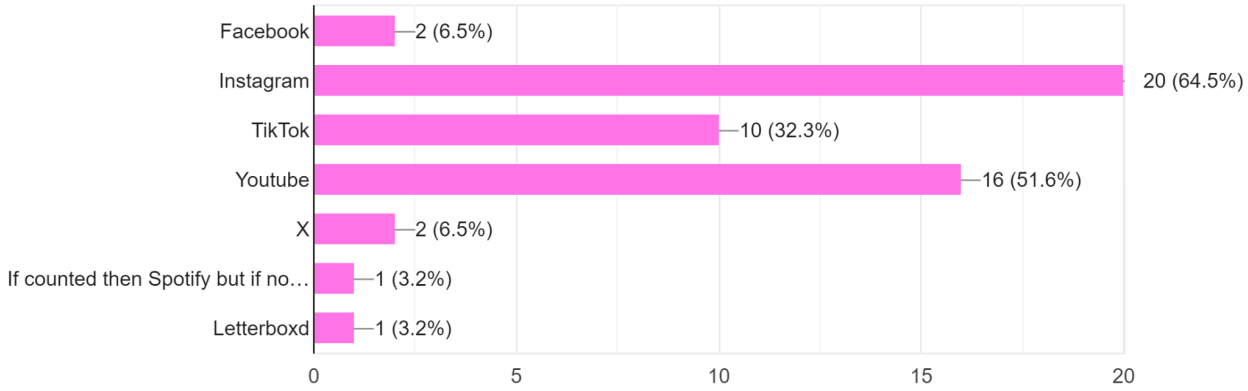
bc i love to discover how things works	สนใจเพราะต้องใช้ในการสอบเข้าแพทย์
Funny	เพราะจะเข้าหมอ
i am interested in science because it explore how the world revolves and works and it's very intriguing	สนใจเนื่องจากเมื่อเกิดการตั้งข้อสงสัยวิทยาศาสตร์สามารถให้คำตอบได้
Im not so interested because i think that it is too complicated for me depending on the subjects	น่าสนใจ และน่าค้นหา
Because It interesting	

What other subjects are you interested in?
นอกจากวิทยาศาสตร์ คุณสนใจวิชาอะไรอีกบ้าง

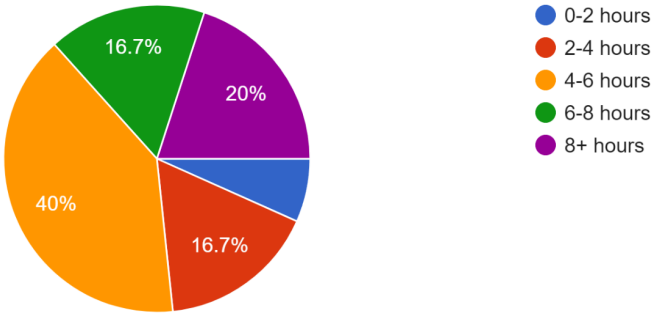
(31 Responses)

I like physical education	I enjoy math and ICT
Technology	Computer
I'm interested in English	Physics
ICT	Computer
Math and ict	Soccer.
Math	Business marketing
Art and music	Music
art	Math and art
I like english and music	English and maths (used to)
Math	คณิตศาสตร์ ดนตรี ศิลปะ
Not really anything	คณิตศาสตร์
languages	คณิตศาสตร์
ICT	เลข
i do like maths because it's very fun when u understand it	สังคม อังกฤษ
Mostly computer studies or online business	คณิตศาสตร์ ภาษาอังกฤษ
PE	

If you use social media, which platform do you use the most?
คุณใช้แพลตฟอร์มโซเชียลมีเดียใดมากที่สุด
(31 Responses)



How much time do you spend on social media daily?
คุณใช้โซเชียลมีเดียวันละกี่ชั่วโมง
(30 Responses)



Do you follow any educational social media accounts? Which ones?
คุณติดตามช่อง/เพจที่มีเนื้อหาทางการศึกษาอยู่หรือไม่ ถ้าติดตาม คุณติดตามช่อง/เพจอะไรบ้าง
(31 Responses)

Tutor 2 u	No
Smarter Everyday, Niel Red, Veritasium ,slow mo guys, stuffs are made here, spaceX	BEST EP
I follow random TikTok accounts that just give out information about different things	japanese english
Yes for example, crash course on YouTube	No
BEST EP school account	-
BEST burapha	I like to watch documentaries or other programmes that talks about psychology of human

Yes ... Goodsax	Yes, best ep
no	Best ep
No I don’t	Sadly, no.
Yes, example I watch educational social video on YouTube	Point of View/English with Lucy/KND studio/IELTS Daily/ฟิสิกส์ by ครูโน้ต/lazybio channel/ETJ English
No	ติมตามช่อง point of view, ฟิสิกส์ by ครูโน๊ต, we mahidol, lazybio, chemistry K
no	ติดตาม ammriss, nerdy nut , laohaifrag , smartmathpro , dlit resources คลังสื่อการสอน , ste.phanie , jamwhy, at home กวดวิชาออนไลน์ , enconcept english to the max , chemistry_k , we by the brain , ครูหวาน : english on air
사물궁이 집합지식,퍄퍄킴 역사,궁금소,세모사,당신이 몰랐던 이야기,지식해적단,	ติดตาม bioislike , BPN ONLINE+ , aimmuno , Nucleus Medical Media , mega study , Physicsfree4TH , point of view , We mahidol , กวดวิชาพี่ส่าย , ครูตู้ DLTV , ครูวาสนา ภูมี เรียนคณิตศาสตร์ออนไลน์ฟรี , ชีวะพี่พี I Bio Cover , ฟิสิกส์ by ครูโน้ต , อาจวรงค์ จันทมาศ , เรียนต่อไหนดี , lazy bio channel , gat eng cool cool
i don’t think i follow any i don’t remember tho	ติดตาม KND studio, FAROSE
Well i wouldn’t follow them but if i need any help in a particular subject i would search jt up	ติดตาม smartmathpro, chemistry K
No	

What type of learner are you? Visual, auditory, read/write, etc.

คุณมีความถนัดในการเรียนรู้แบบใดมากที่สุด เช่น การเห็นภาพจริง, การฟัง, การอ่าน, อื่นๆ

(30 Responses)

Everything	Visual
Visual	visual and auditory
Visual	Visual
Auditory	Visual
A visual learner	Not sure.
Visual leaner	If it is exam studying, I read and highlight the important lines in the books and rewrite on my study notebook. After that I read again various times
Visual	I need quite room
visual	Visual

Probably Visual auditory	Visual and auditory.
Read	Read
Visual auditory	การอ่าน ทำความเข้าใจ, ทำโจทย์เยอะ ๆ
read/write	การเข้าใจเนื้อหานั้น การเรียน และการเป็นคนเล่าให้เพื่อนฟัง
Visual,write	การเห็นภาพจริง
it’s kindve depends on how i’m feeling during the day but typically im a visual	การเห็นภาพจริง และ การฟัง
Visual	การเห็นจากรูปภาพ

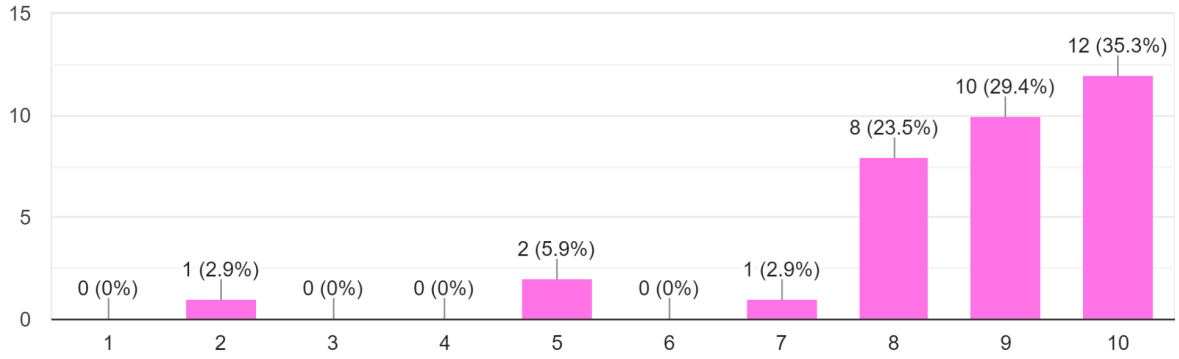
What do you think could increase your interest in science?
มีอะไรบ้างที่จะสามารถทำให้คุณสนใจวิทยาศาสตร์มากขึ้น

(31 Responses)

More fun in class and less lectures pls	Not sure but I would say more experiments
None. I like science	Space, Universe anything outside our world
If the teacher is interesting then I’ll enjoy science more	school
More experiments	Nothing
Doing more experiments and showing more science i am interested in	Plants.
Doing more experiments	Bringing a better teacher
I'm not sure ..	Bring a funny teacher or school
by understanding more of it	A better teacher and new interesting topics
I don’t have thought on what could increase my interest in science right now but i feel like the classes and the studies should be more fun and entertaining but you get knowledge from it	Maybe if it more simple to understand.
More experiment	การเกิดคำถามต่อสิ่งรอบตัว และมีความต้องการที่จะหาคำตอบ
None	เนื้อหาน่าสนใจ
learn the things i want to learn	เมื่อสามารถจำสูตรได้
Look for interesting space.	การได้ทดลองใหม่ ๆ , การเห็นอนิเมชั่นเกี่ยวกับวิทยาศาสตร์
it being more interactive and being involved more	การทดลองวิทยาศาสตร์, ทฤษฎีทางวิทยาศาสตร์
Do fun experiments	เรื่องใหม่ๆที่ค้นพบ
If it look cool	

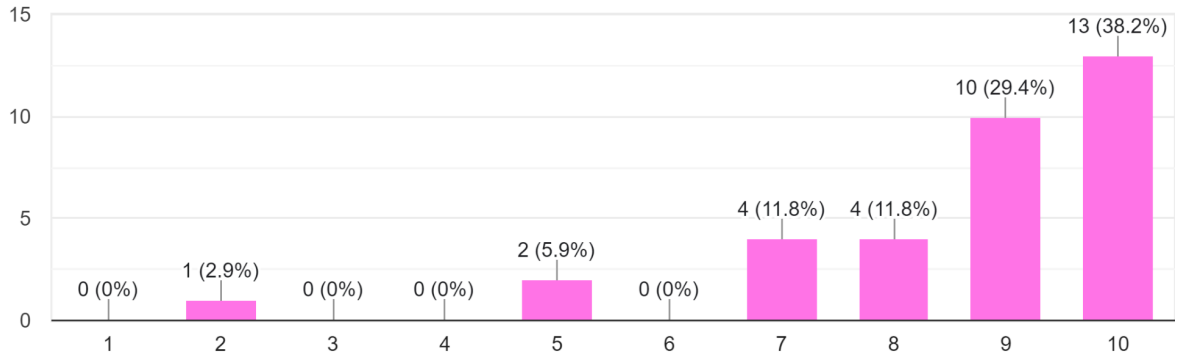
Appendix H: Survey Results from Pre-Event Survey (N = 34)

I find science class interesting



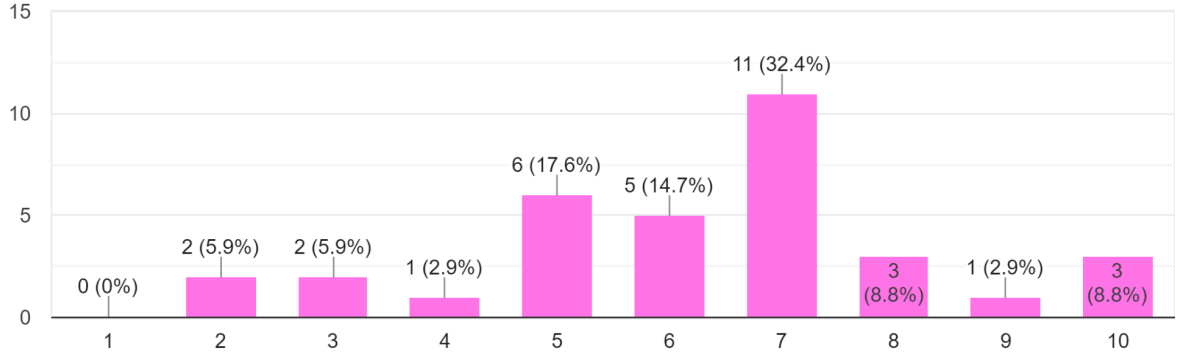
Mean = 8.617647059	Median = 9	Mode = 10

I look forward to my science class



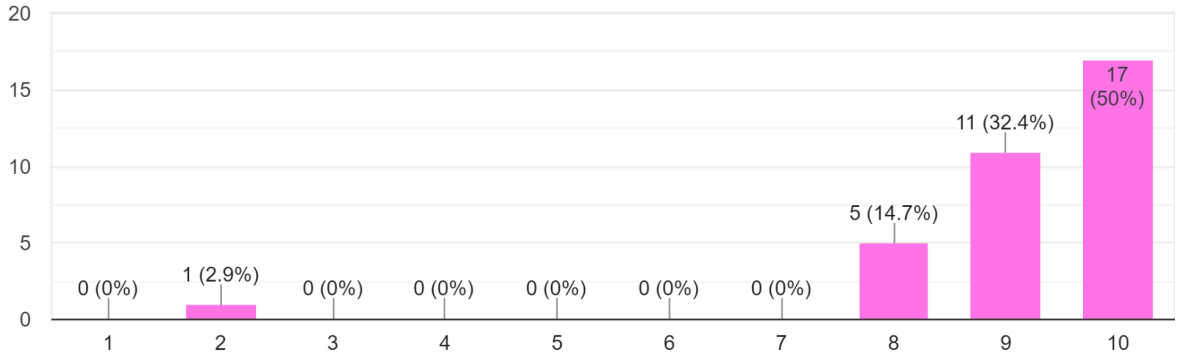
Mean = 8.588235294	Median = 9	Mode = 10

Science is difficult to me



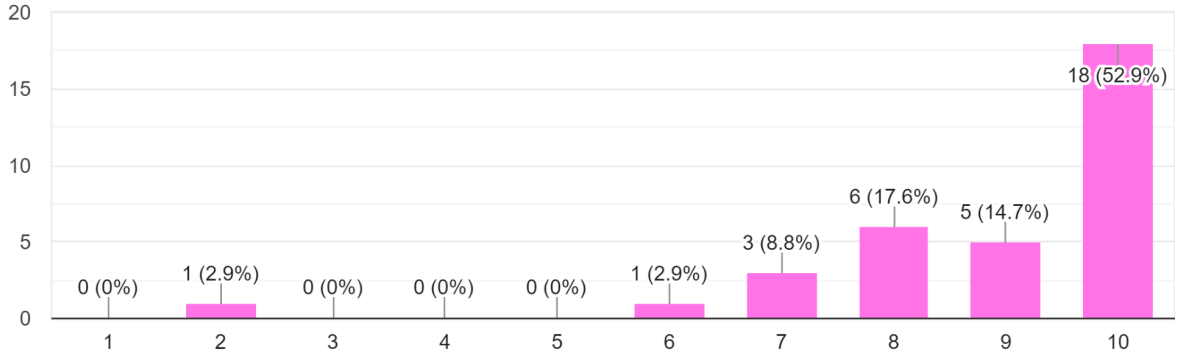
Mean = 6.294117647	Median = 7	Mode = 7

Practical/lab work in science is interesting



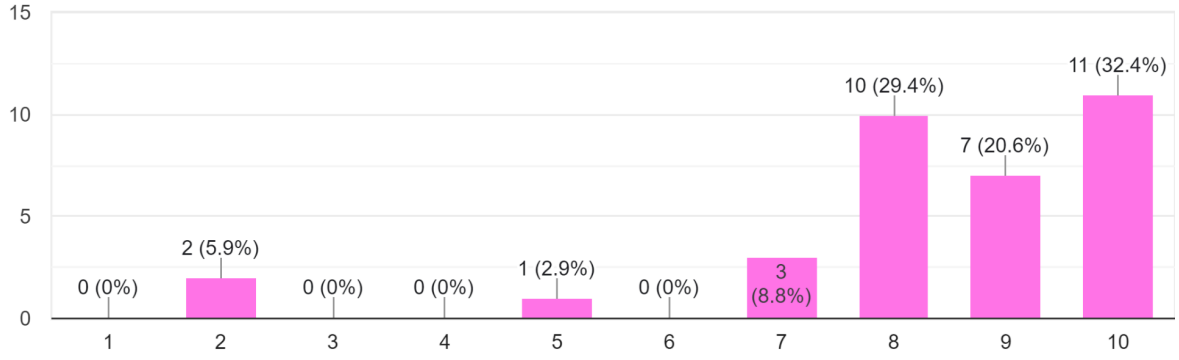
Mean = 9.147058824	Median = 9.5	Mode = 10

I would rather do practical/lab work than attend lectures



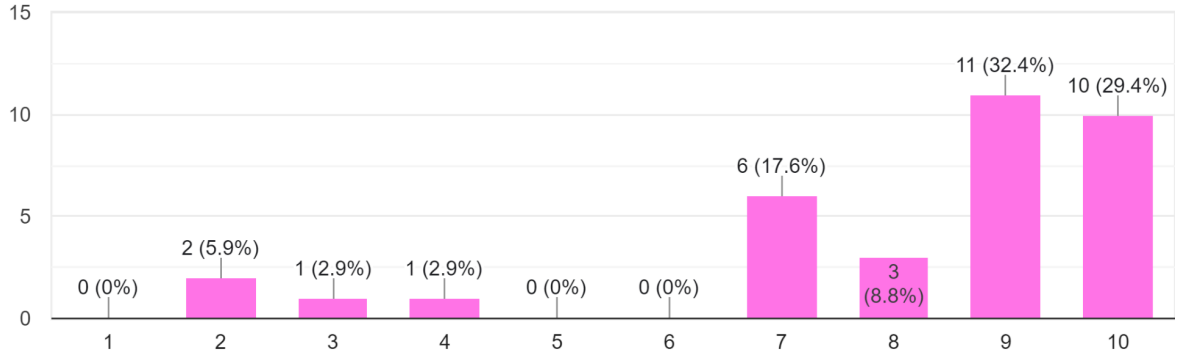
Mean = 8.882352941	Median = 10	Mode = 10

I would like to study science at university



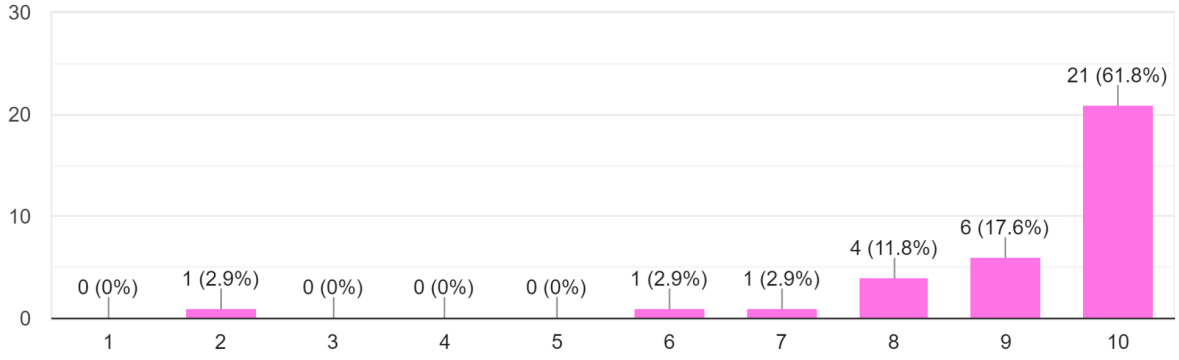
Mean = 8.323529412	Median = 9	Mode = 10

I would like to get a job or career in science



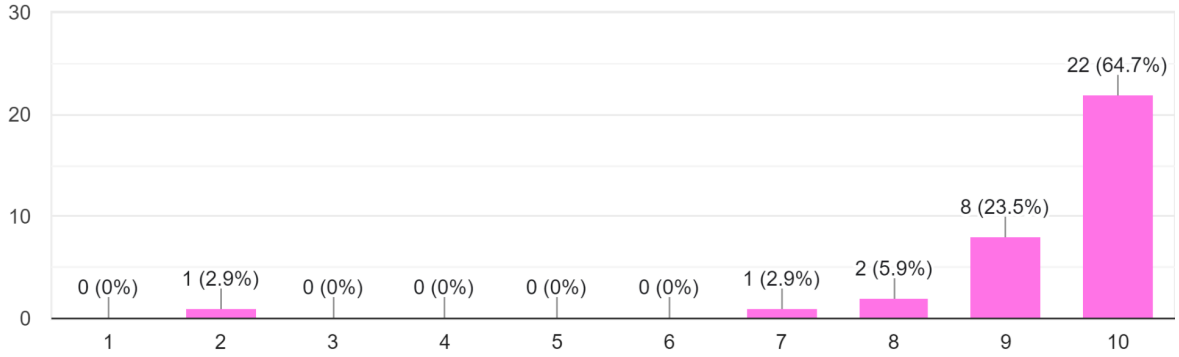
Mean = 8.117647059	Median = 9	Mode = 9

I believe science and technology is important for society



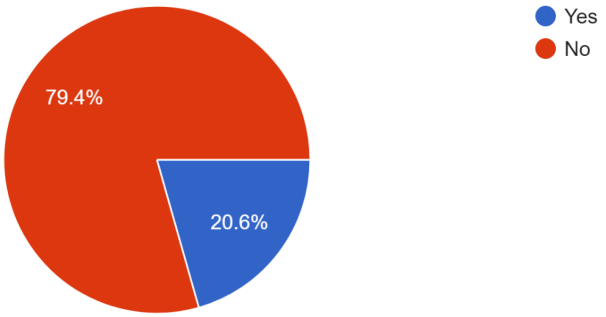
Mean = 9.147058824	Median = 10	Mode = 10

I believe science and technology makes our lives easier

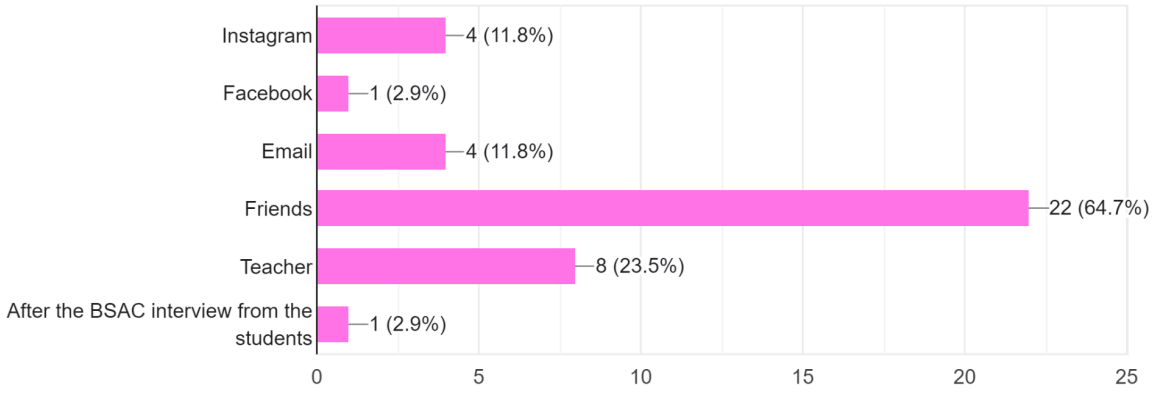


Mean = 9.323529412	Median = 10	Mode = 10

Are you part of an international program?



How did you find out about this event?



Why did you choose the electroplating/surface tension experiment(s)?

Because These experiments are fundamental principles of chemistry and physics that allow us to clearly see the concepts of chemical reactions, and I am very interested in this topic.	It looks interesting and I would like to try something like this.
I just like science because that interesting .🤩🤩	To help me understand the basic principles. This experiment provide practical learning opportunities, creating connections between chemistry and physics.
I thought it was interesting and wanted to try something new.	I choose electroplating because Now i'm study about eletroplating and I want to learn about this more than i know.
I'm so interesting in this	Because it is the most interesting
Because this event is interesting.	เพราะว่าสนใจอยากรู้เกี่ยวกับปฏิกิริยาเคมีที่เกิดขึ้น
It is something interesting and would like to study.	เลือกการชุบไฟฟ้าเพราะว่าอยากเรียนรู้เรื่องไฟฟ้าทางวิทยาศาสตร์ในการไปร่วมกิจกรรมนี้ครับ
It is something interesting and would like to study.	I think the electroplating a little bit interesting more than surface tension experiment and I want to try essay about the electroplating.
It is interesting and would like to study about its.	I would like to know what kind of studies this faculty has
Because I'm interested in science	I want more knowledge that I could use for study
It seemed interesting and exciting. Plus, I've never done it before.	I am interested in electroplating and surface tension. I think it can be use d for further development
it seems interesting	I chose it because I wanted to learn about electricity in this activity and it was an interesting activity name.
I'm interested	So interesting and I like learn about that

because I'm interested in this experiment and want to learn this	electroplating because happy
I’m interested in this experiment	I have an interest in this
I’m interested in this	I am interested in electroplating because it sound interesting to me.
It can be applied in many ways. and is interesting.	This option seemed very interesting to me
I feel interested and like it.	I had interest in electroplating since one of my school lectures about electrolysis and electroplating

Appendix I: Survey Results from Post-Event Survey (N = 41)

What did you like/not like about the Introduction?

(41 Responses)

I like it so mucjhhhhhhh	I like staff they tell everything I want to know
How friendly and educated the staffs are	ชอบการให้ความร่วมมือช่วยกัน
The introduction was fun and entertaining and i dont have anything that i didnt like about it.	I like it very much cuz you're so friendly and the introduction is so good.
Like	I like about the friendliness of everyone and lab work.
I like it.	หนูชอบค่ะตรงที่ว่านอกจากจะให้รู้จักกันและกันแล้วยังให้ความสนุกระหว่างแนะนำตัวด้วย
I like both of all	I like Operation of Lap
I like about the introduction part that it gives a clearly explanation about what we are going to do today.	I like Everything
I liked the presenters and how clear they explained what we'd have to do for the event	Yes i like
The discussion was fine as we get to hear other opinions, I don't have any complaints for the introduction	I like everything.
I like	I like the introduction
I like project	I like everything
I like how it is fun, and entertaining	I like everything because very interesting.
I like how clear the introductions were and how considerate the staffs were	I like about lab because I got some more knowledge and it was fun
I like	The introduction is good.
No problems with the introduction	I appreciate that the explanations are easy to understand and leave no room for confusion.
No problems	การให้ความร่วมมือของเพื่อนๆและเอนเนอร์จี้ของพี่ๆ
I like the staff that tell me anything I want to know	I like how he explains it well.
Yes i like. I think I gained knowledge and skills in presenting my work.	I like the way he talks and understands things.
I like the experiments here.	I like about lab.
I like that introduction briefly introduced us to electroplating.	I like the friendliness of the staff.
Yes I like.	

What did you like/not like about the Lab?

(41 Responses)

like sure	I like everything in lab
The lab was a bit hot due to not much airflow but it was all fine by me	ชอบที่ได้ลองมือทำ และได้ของกลับกลับไป
the lab was fully equipped and fun but the instructions were not very clear.	I like it cuz it so amazing.
Like	I like that when a nail is dipped in copper, it changes the reaction.
I like it.	หนูชอบlabนี้ตรงที่เราได้ทดลองและได้ของฝากกลับบ้านไปด้วยค่ะซึ่งถือเป็นความทรงจำเล็กๆน้อยๆว่าเราเคยมาค่ะ
I like both	I like everything about Lap because that interesting
I think that it takes too long in the lab since many things could be wrap up more quickly. However, this experiment is interesting.	I like Helping to guide in the lab
I liked how we had a lot of freedom to experiment on our own will and investigate the results completely on our own	Yes,i like
I like how every materials was prepared for us and there are instructions ready, my only complaints would be time management as I feel like it was too long for me	I don't like the temperature in lap room that's very hot, But i like everything other the hot temperature.
I like all	I like doing lab work because it's fun
I think it's good.	I like experimenting with everything these days.
I like how we get to try and fool around a little after the objectives have been completed	There's nothing I don't like, everyone recommends it very well.
I liked every aspect of about the lad. It was fun and I got to try experiments that I would not have been able to do elsewhere	I like It. Because (like Question 1)
I like	I like to do the lab because sometimes in the I didn’t do the lab but when I came here I can do it.
I liked how everything was well prepared, instructions clear, and how the items were labeled clearly.	The lab is fascinating and a lot of fun, but it can get a bit warm.
I liked seeing the process of electro plating with my own eyes. I had no problems with it.	ชอบการทดลองใหม่ๆที่ไม่เคยทดลองและความรู้ที่ได้จากการทดลอง
I like about the lead and copper	The experimenting time was very fun, with seniors always there to give advice.
I liked today's lab. There were many things to try.	I like the freedom to do it.
I like it, easy to understand and fun.	I like the way keychain changes colors.

I like that we get to do electroplating on different metals (zinc, copper and lead) and try it with nails and keychain. This demonstrates on how the process works, creating a visual representation of electrochemistry for students to visualize and learn. There's nothing I don't like about the lab but it would be better if we can do different experiments as well🥺🙏	I love seeing the key change color.
Yea very like.	

What did you like/not like about the Electroplating Discussion?

(41 Responses)

Like too	I like when the color is change
How informative the slides are	ชอบที่มีภาพประกอบให้เห็น และให้ทำความเข้าใจ
The discussion was all fine we get to hear other people ideas and opinions.	I like it cuz I got new knowledge.
Like	I like that everything is explained in an easy to understand way.
I like it.	ชอบค่ะเพราะพี่ๆอธิบายได้เข้าใจง่ายและก็ใจดีกันมากค่ะ
I like both	I like
This session provides new knowledge about electroplating.	I think They did a great
I like how theey explained it using a diagram and how clearly they showed the examples	Yes,i like it
I like that I get to hear different ideas from a lot of people, I have no complaints for this	I like everything about the Electroplating.
I like	I like Electroplating Discussion
I like this story.	I like teamwork
I like how it's simplified, while is also able to cover all the important points	Like everything but I'm a little excited but it's fun.
The electroplating discussion was very helpful can clear	I like it. Because i got more way to do lab in my future
I like	I can get many knowledge from the discussion.
I felt like it was a bit rushed	It's knowledge that can be applied in various ways in everyday life.
I had no problems with it.	ชอบความรู้ใหม่ๆ
I not like about I can't understand English	I like the easy to understand explanation.
Electroplating will cause a color change in the	I like the way he talks and understands things.

workpiece that we dip into the solution. The working principle is to move electrons towards the battery that we use and the substance will coat the workpiece through the solution. that	
I like it because the content is interesting.	I like it because it can use in daily life.
The discussion is a bit too short so I'm a bit confused about electroplating but when I gathered into groups with my group mates and searched more information regarding the topic, I found that the topic is a lot easier than I think.	I like the opportunity to shine a light on each other opinions
Yea I like it.	

What did you like/not like about the Brainstorming Session?

(41 Responses)

Likeeee	I like a president of my company
This activity helps improves our cognitive skills and team working skills	ชอบที่ได้ระดมความคิดได้รวดเร็ว และกวีให้ความร่วมมือกัน
It was very challenging thinking of an idea but it was not very bad and entertaining i would say.	I like it cuz I have new friends.
Like	I like to brainstorm with friends in the group and come up with new things to present.
I like it.	หนูชอบตรงที่ทำให้เราได้รู้จักประสานงานกับคนใหม่ๆด้วยค่ะ
I like both	teamwork
It is fun and to have new friends from other schools. We discuss and share our opinion.	It good idea
I like how we could design how our presentation would look like and they gave us a decent amount of time to speak	Yessir because i have very good friends.
I like that I get to exercise my thoughts and brainstorm with my friends, my complain would be that the time given for us is too short.	I like it because my friends really help the work but i don't like a little bit because my one friend don't help us work.
I like	I like it Because I feel like it's fun
I like to help each other think.	i like because it teamwork
The brainstorming session went well and i like that i get to exercise my thoughts with my friends, though i would like to try the private room at least once	There's nothing I don't like, it's fun.
The time period they gave for the brainstorming session was a lot and it helped our team to come up with a great presentation	I like it. Because me and team spend some time togeter to think about presentation and summary my knowledge

I like	I can develop the friendship in the group by helping each other to create a good presentation.
I felt like they should have made a slide with clear instructions of what to so instead of just flat out just giving the criteria.	I've had a unique experience and made new friends.
I felt the steps for the presentation needed to be a bit more clear. We were confused on what was supposed to be in the presentation.	ชอบความสามัคคีและได้ฝึกทำงานกับผู้อื่น
I like my president of my company	I like it because we are more united.
I think everyone did their best to help each other think and present the work well without any problems.	I like it because we in the group get to think together and make us closer and have more fun together.
I like it because I exchange knowledge in the work.	helped each other think and find topics to present.
We get to shred our ideas and brainstorm. Although my group members found this hard so I mostly do the work. Other than that, we get to share our discussion and overall I had a great time 😊👍🏻	I like my president of my company
Yes I like, is so good my team have friendship very much.	

What did you like/not like about the Pitches?

(41 Responses)

Likeeee	I not like when everyone so serious
The information giving by the other groups were nicely done	ชอบที่ได้เห็นการพรีเซ้นท์ที่หลากหลายและได้ความรู้เพิ่มมากขึ้น
It was fun hearing other people’s ideas so i would say it was very fun.	I like it cuz I have new experience.
Like	I felt excited and nervous because the questions were quite in-depth and my group had not been able to find the information thoroughly enough.
I like it.	หนูชอบค่ะเพราะทำให้เราได้รู้จักการกล้าแสดงออกและยังช่วยทำให้เรารู้จักการพยายามในการสื่อสารด้วยค่ะ
I like both	I like here place
The Pitches part is very fun and enthusiastic. I would like to know other group idea about their product.	I think it so very goodddd idea
I love how creative the pitches were and how the people used the resources they could so that they could explain their product	Yeah very nice 👍
I like that I get to see the products suggested by	I like this pitches.

many people	
I like pitches	I like it
I like	I like everything
The pitches went smoothly and everyone's presentation was good	Of course I like it.
The pitches took too long because there was multiple groups	I like it. Because i like to see what other people think about electroplating
I like	I like to listen to the other group presentation to know the new knowledge.
For me personally, Im not great at thai so the presentations that were done in thai were a bit hard to understand.	I gained new experiences and acquired intriguing knowledge.
Some of the presentations were in Thai which made it hard for us to understand. However this is just a minor nitpick no worries!	ชอบการให้คำแนะนำจากกรรมการ
I don’t like the pitches because every group is serious but not mine	I like having snacks and the people are kind.
Today's presentation may involve not being brave or not understanding many things, but I like it.	I like the cool air conditioning.
I don't like it because it's quite uncomfortable.	It gives me courage to express my opinions.
Pitches are only 3 minutes which for me is a bit short. It would be better if you give us longer time such as 5 minutes to demonstrates our idea. We also went our 17.00 🥲	I like it because it seems to create laughter.
Yes I very like.	

What did you learn about electrochemistry?

(41 Responses)

I learn more ab eletrochemistry without teacher in class	I learned what colors are combined with what.
For different metals , a different solution must be use , some metals use have there own different properties	ไฟฟ้าเคมีมีผลต่อปฏิกิริยาต่างๆในชีวิตประจำ หรืออาจจะทำให้เราใช้ชีวิตได้สะดวกมากขึ้น
That we use electrochemistry alot in our daily lives and that it is important for us.	The colour it isn't rush it clause Electrolytic Cell.
รู้ว่ามีประโชยน์ยังไงกับชีวิตประจำวัน	Learn about metal plating and other general basic knowledge.
Electroplating	ทำให้หนูได้รู้จักหลักการเคมีไฟฟ้าต่างๆและได้รู้จักการนำมันมาประยุกต์ใช้ด้วยค่ะ

Work process of electrochemistry	Teamworking,research
It is the transferring of electrons from one metal to another.	Experimenting with redox reactions in electrochemistry
How useful it is in our daily lives and how diverse it could be used by using electricity	I learn about electrolytic cell.
How electroplating work, use of electroplating, etc.	About elctroplating lab , I have new knowledge in this day because this class Thank u🤍🤍
Learned which metals conduct and which do not	About electrochemistry lab
Metal plating	I learned what electrochemistry can do.
How electroplating works. How it has a lot of applications, and is very versatile	I learned about electron transfer.
The event today helped me understand all the aspects of electroplating and how it works	electrochemistry can use in daily life
know the principles and methods	I learn how the electron run in the reaction, the anode cathode, the electrolytic cell.
I learned literally the aspect of electroplating because beforehand I had no idea that this even existed	I've learned about electroplating, where the application of electricity causes the color of one metal to adhere to another metal.
I didn't even realize how much electro chemistry was used before we learned it today. So pretty much the process of electro chemistry.	Electrolytic Cell
This lab make me know how to change the metal	I learned to transfer electrons to change the color of a keychain.
Electrochemistry has many applications in daily life and can be used in daily life.	I learned about the movement of electrons. electron transfer Know how the keychain's color change occurs.
I learned about Electroplating.	I learn about electroplating can use in daily life.
Electrochemistry is the study of chemical processes that cause electrons to move. This movement of electrons is called electricity, which can be generated by movements of electrons from one element to another in a reaction known as a redox reaction	Learned about electrochemistry
I learn electrolytic cells.	

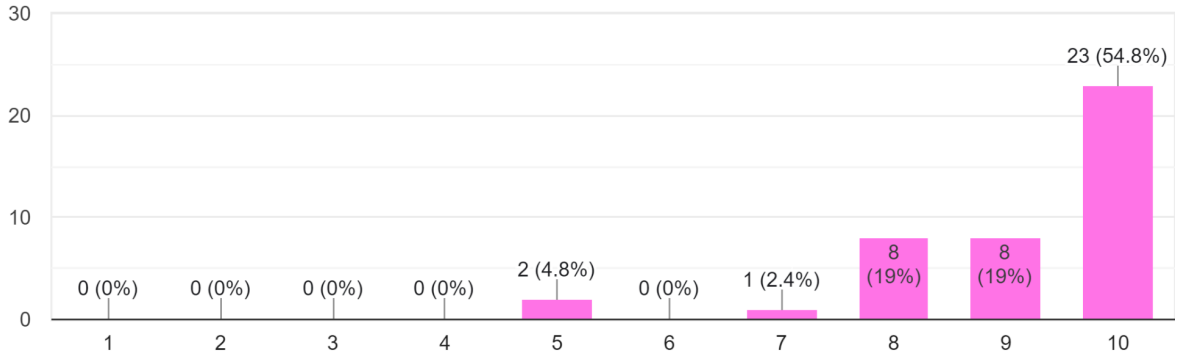
Do you have any suggestions on how the event can be improved?

(40 Responses)

No ka	No,I don't
No , the event was well over perfect! 👍🏻	-

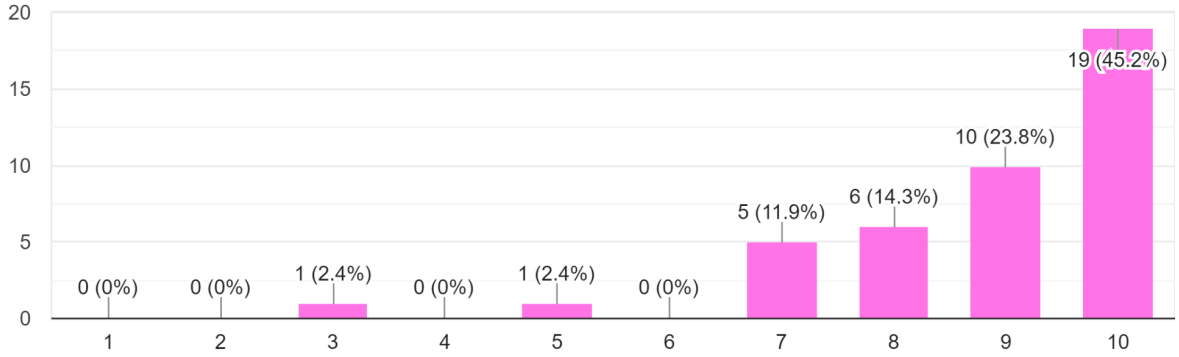
I would say to make the lab instructions abit more clear.	I don't have it
No	I like everything about this event. Very friendliness.
Nothing it’s good already.	ไม่มีค่ะ
I think that the experiment part should be quicker.	Not have
None I had a lot of fun :)	🫶🏻
Time management could be improved	I don't have,it too good enough
No	Nope
No	Nope
It is already very good, though it would've been better if the time we get to try the experiments are a bit longer	No
I think that the event is already good so in my opinion it has nothing to improve on	Nothing
No, because it's already good.	I didn't have
I think overall the event was great.	-
None	I would like to extend the time for completing the project.
The pressure can be low than this can be good	No
I don't have much to recommend because this session was very good to study electrochemistry and had fun activities.	I would feel like I was missing out a lot if I didn't come here.
I think the presentation was too stressful.	NO I don't
I want to do more experiments other than electroplating. But I really like this event, I helped me learn more about how the electroplating works, etc. I also made new friends 😆	No I dont
I don’t have because is so good now.	No, because they organized this event very well

I find science class interesting



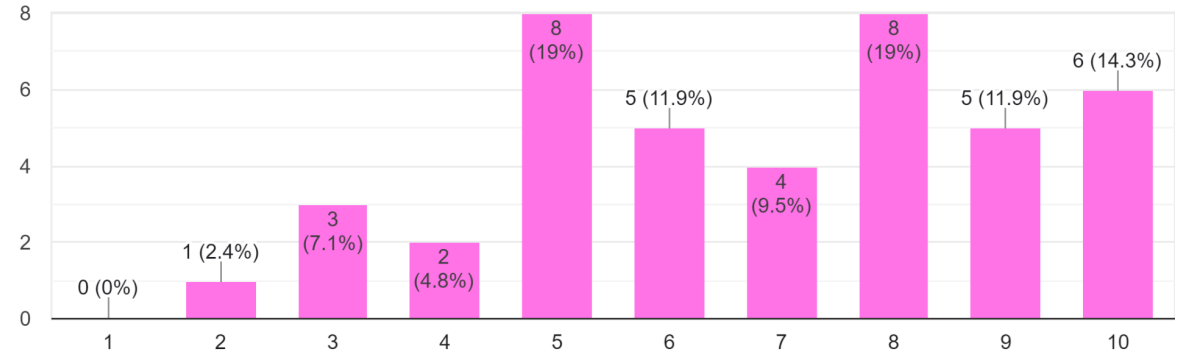
Mean = 9.146341463	Median = 10	Mode = 10

I look forward to my science class



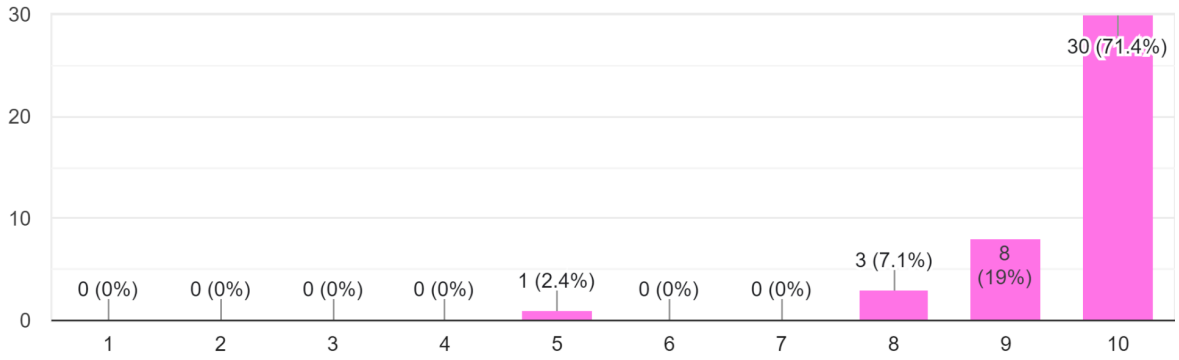
Mean = 8.829268293	Median = 9	Mode = 10

Science is difficult to me



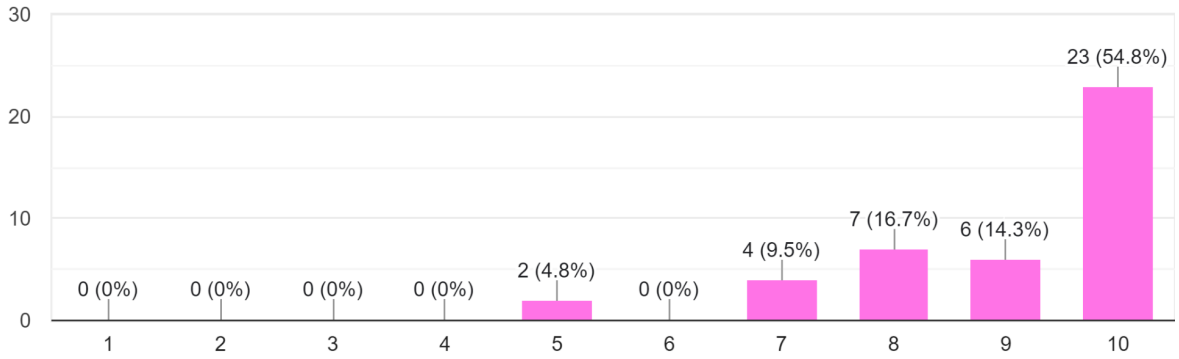
Mean = 6.780487805	Median = 7	Mode = 5

Practical/lab work in science is interesting



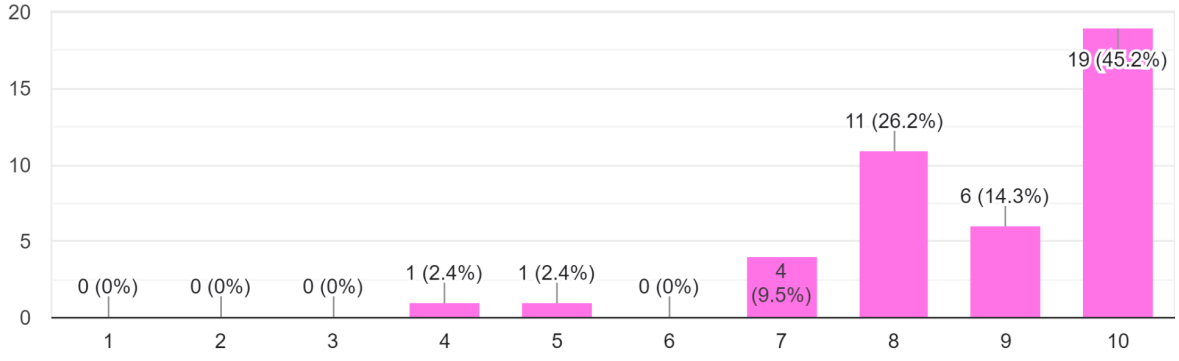
Mean = 9.56097561	Median = 10	Mode = 10

I would rather do practical/lab work than attend lectures



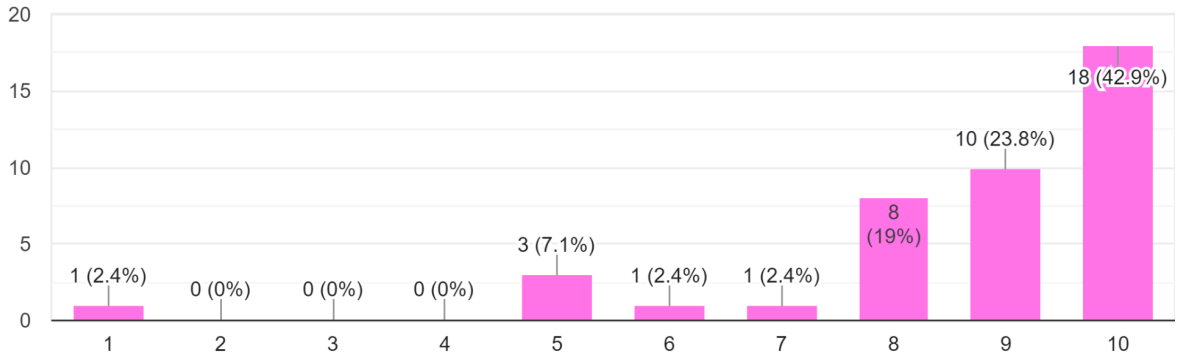
Mean = 9.024390244	Median = 10	Mode = 10

I would like to study science at university



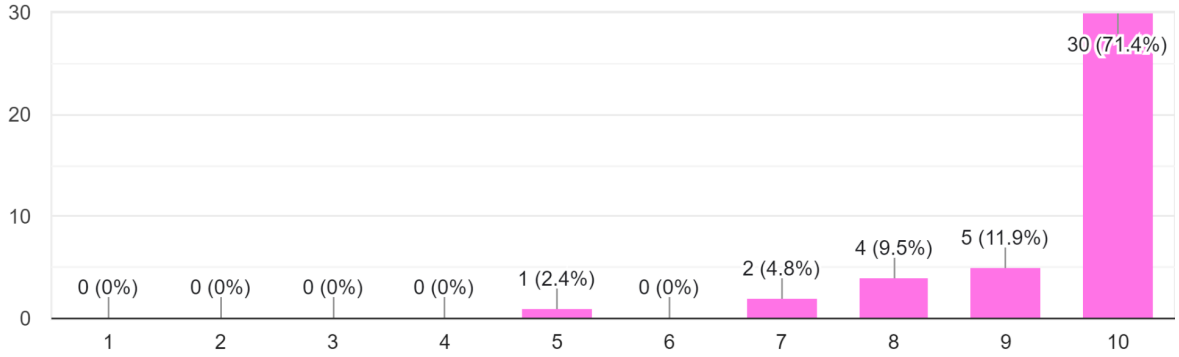
Mean = 8.804878049	Median = 9	Mode = 10

I would like to get a job or career in science



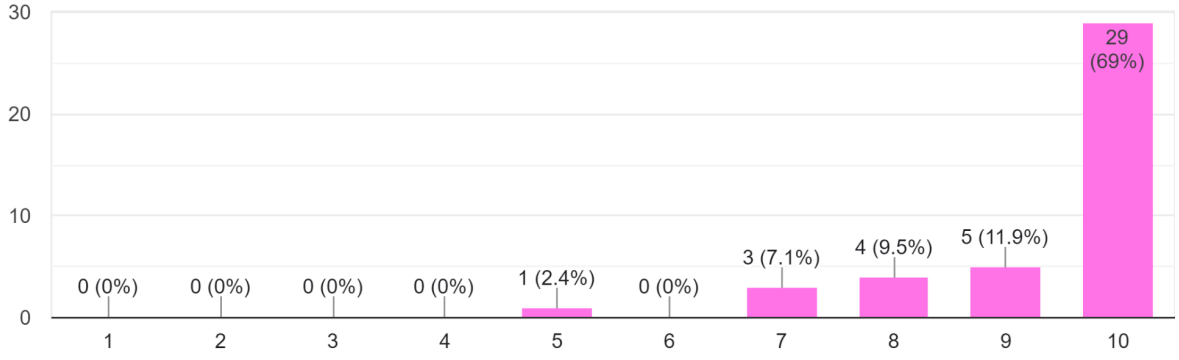
Mean = 8.634146341	Median = 9	Mode = 10

I believe science and technology is important for society



Mean = 9.43902439	Median = 10	Mode = 10

I believe science and technology makes our lives easier

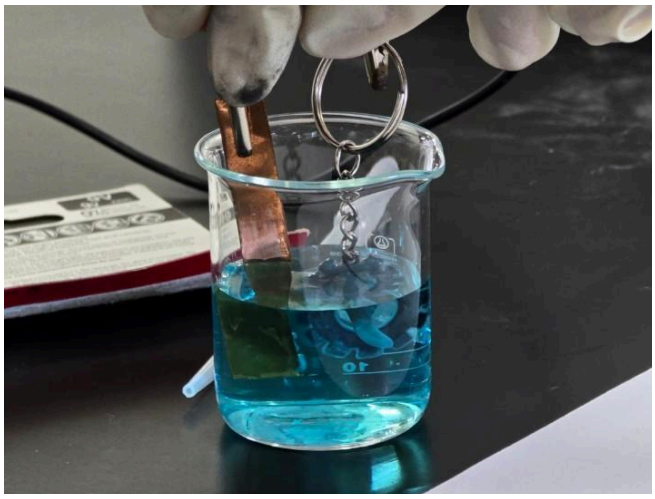


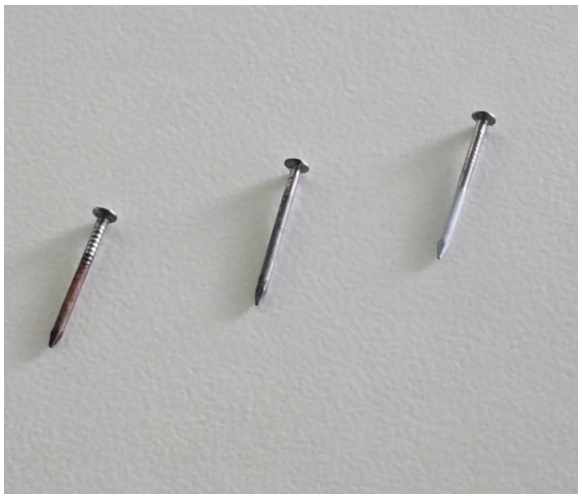
Mean = 9.341463415	Median = 10	Mode = 10

Appendix J: Electroplating Experiment

Macroscopic Level

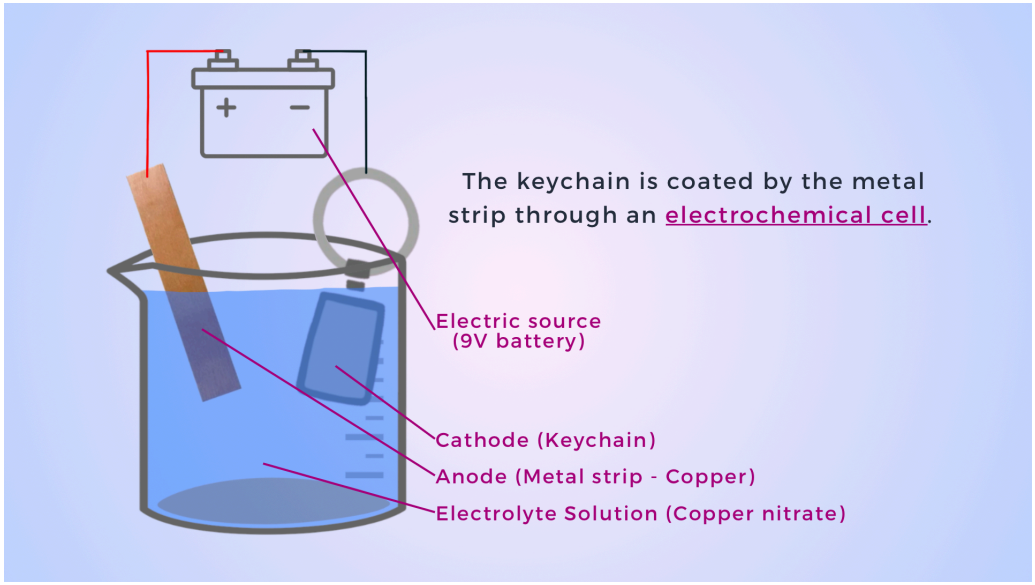
Electroplating is the process of using electricity to deposit one metal onto another. Simply connect a copper electrode to a keychain immersed in a solution of copper nitrate to a power supply, and after a few minutes you will get a keychain coated with copper.





Submicroscopic Level

The potential difference/applied voltage will free the metal ions from its original solid e.g. copper and make them travel through the electrolyte solution e.g.copper nitrate to get deposited onto our object of interest e.g. keychain.



Symbolic Level

The process of "freeing" the metal ions relies on a reaction called oxidation, which is characterized by the loss of electrons. The process of depositing the metal ions onto the keychain relies on a reaction called reduction, which is characterized by the gain of electrons. Both of these processes occurring simultaneously gives us a redox reaction, which is represented by the equations below:

Anode Reaction (Oxidation)

$Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2e^-$

Cathode Reaction (Reduction)

$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$

Applications of Electrochemistry

Ion detection (environmental analysis), batteries, and metal purification.

Guiding Questions

- What is this system called?
- What are the components of an electrochemical cell?
- What is happening at the anode?
- What is happening at the cathode?
- What is the overall reaction called?

Metals Used in this Experiment (for plating)

- Copper (Blue Electrolyte Solution)
- Zinc (Clear Electrolyte Solution)
- Lead (Clear Electrolyte Solution)

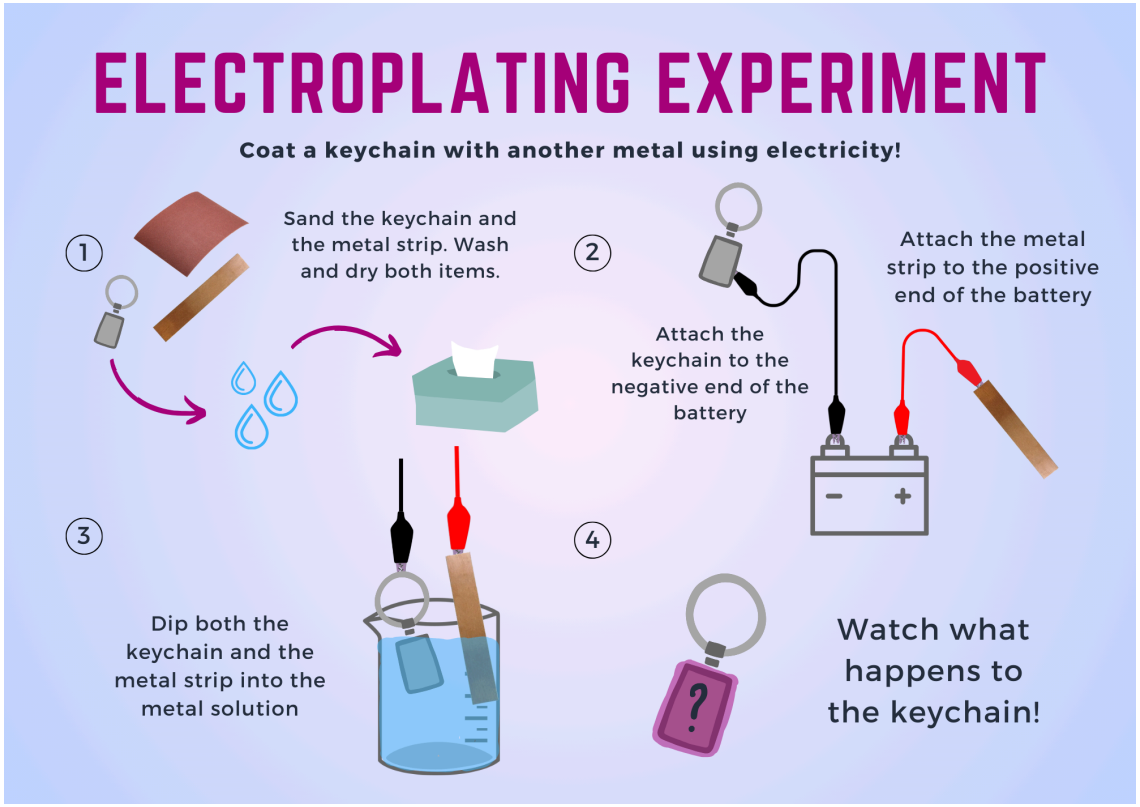
Materials Required

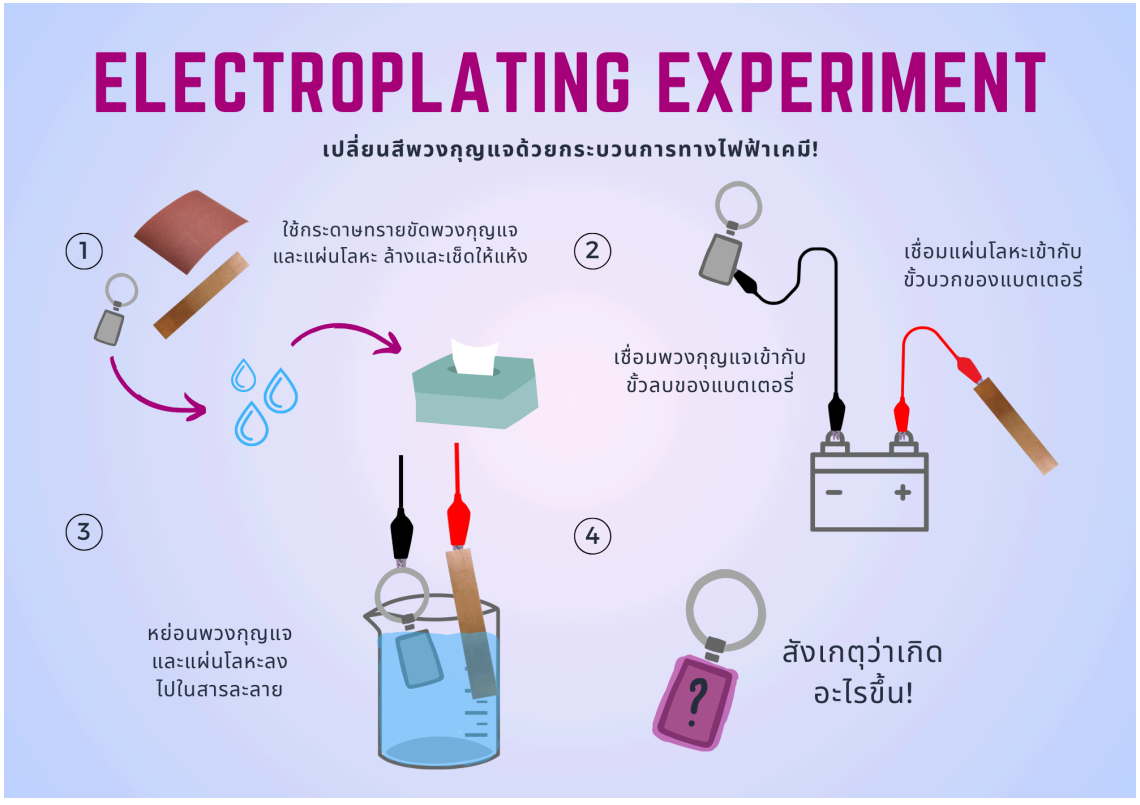
- Copper nitrate, zinc nitrate, lead nitrate
- Power Source (9V Battery)
- Alligator Clips (Red and Black)
- 50 mL Beakers
- Nails
- Copper, Zinc, Lead electrode (Pure copper, zinc, lead strips)
- Keychain
- Sandpaper

Manual Includes

- Instructions for the electroplating experiment

Appendix K: Lab Instruction Manual





Appendix L: Judging Rubric

Ion Spire: Energizing Ideas

Presentation Rubric

	4	3	2	1
Content	Students demonstrate a comprehensive knowledge of the topic and applies knowledge accurately to the pitch.	Students understand the topic but can't quite accurately apply the knowledge to the pitch.	Students show limited knowledge on the topic or can't accurately apply the knowledge to the pitch.	Students do not display an understanding of the topic and thus can't accurately apply the knowledge to the pitch.
Clarity	Students have a clear and understandable pitch for their product.	Students have a mostly understandable pitch. A few clarifying questions need to be asked to fully understand.	Students have a somewhat understandable pitch, but many questions needed to be asked to fully understand product.	Students do not have an understandable pitch.
Presentation	Students present in a professional manner, they are well heard, have eye contact with the audience and have appropriate body language.	Students present in a mostly professional manner, they sometimes are well heard, have eye contact or appropriate body language.	Students present in a somewhat professional manner, they rarely are well heard, have eye contact or appropriate body language.	Students present in a non-professional or unacceptable manner.
Organization	Students' presentation is very easy to follow and is presented in a creative manner.	Students' presentation is somewhat easy to follow, and presented in a creative matter.	Students' presentation is somewhat hard to follow.	Students' presentation is hard to follow.

Appendix M: Project Sustainability Plan

Building Scientific Literacy Among Thai Youth

Project Sustainability Plan

Developed by IQP-ISSP5
2024 Bangkok Project Center

BSAC CHULA THE PRINCIPIA WPI

Introduction

The Principia currently engages with students through science articles, informational social media posts, and participating in science events in the Bangkok area. In addition to science content, their work focuses on science communication and engagement, hosting various events such as the Science Communication Festival. Previously, the youngest audience The Principia has worked with has been undergraduate students. They are now looking to target younger audiences.

2

Project Overview

Our project team from Chulalongkorn University and Worcester Polytechnic Institute was tasked with assisting The Principia in building scientific literacy among Thai youth. To achieve this goal, we developed the following objectives to investigate and provide recommendations on scientific literacy in Thai youth.

- Identify Current Science Interest
- Develop Inquiry & Project Based Learning Principles
- Host an Interactive Science Event
- Analyze Collected Data to Create Recommendations

3

Sustainability Plan Overview

The project sustainability plan is a document that clearly outlines specific goals and criteria that influenced our project, and how The Principia can sustain those goals. It is broken into six categories.

4

Mission

Having a coherent mission/overall goal for the organization or project.

The goal of this project was to find and evaluate strategies to increase scientific literacy among Thai youth. We achieved that through multiple objectives that we constantly evaluated.

Based on our goal, we recommend that The Principia evaluates their goal for this project. In addition to simply building scientific literacy in younger students, we encourage them to build off of our objectives that address questions such as:

- What do we want students to learn?
- What is the optimal way to teach students?
- How do we evaluate scientific literacy?

5

Evaluation

Having a strong method of evaluating success both internally & externally.

In the past, The Principia has not had direct access to feedback from events they had participated in. Our approach utilized several strategies such as observations and surveys to evaluate our event.

We recommend that The Principia focuses on developing strategies to evaluate their events and collect feedback.

6

Adaptability

Having the abilty to adapt to changing circumstances.

The Principia excels at staying up to date with the most relevant scientific information, often creating articles or social media posts on the topics.
Additionally, our event required us to change details on the spot due to varying attendance, and other unseen circumstances.

In addition to continuing their social media engagement, we recommend that The Principia continues to adapt their events to stay relevant.
To address unseen circumstances, we encourage discussion of different possibilities and their solutions. For example, how to address a greater attendance than expected.

7

Scalability

Having the ability to scale capacity or capabilities up or down as needed.

Our event was designed to host 50 students. However, we saw that there was much greater interest than what we could accomodate.

We recommend that The Principia uses information from their evaluation to scale up or down their events. While changes may not be addressed immediately, acknowledging the requirements is important.

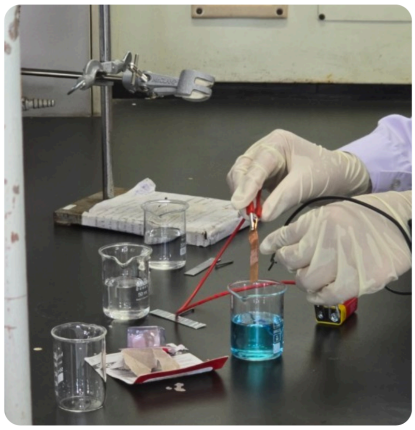
8

Integration

Having the ability to integrate with existing initiatives.

The current upper secondary science curriculum touches on the basics of several topics, such as electrochemistry. We were able to integrate by allowing students to further investigate this topic.

We recommend that The Principia forms partnerships with existing organizations to utilize their resources and further increase the impact on students.



9

Community

Having the ability to connect with the community and gather feedback.

We were able to connect with students from across Bangkok through our event, and engage them in science activities.

We recommend that The Principia use their partnerships to promote their events and attract more participants. This also increases their reach.

10

Recommendations

Based on our project findings, we have outlined three recommendations for The Principia. Further details can be found in our project report. The six elements of the project sustainability plan can be applied to these recommendations.

Engage through Instagram

Use a handful of strategies to improve Scientific Literacy

Form Partnerships

11

Passavit Apinanthawachpong
Macy Antonette D. Castillo
Adhicha Chalermchuang
Aman Hiregoudar
Amrit Kaur
Nicholas Kirby
Steven Oliner
Ranvir Sirikogar

BSAC CHULA

THE PRINCIPIA

WPI