



# WPI

## Using Immersive Fantasy to Engage Marginalized Youth: Promoting STEM Engagement Using Mystery Rooms

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December 12, 2018

## Abstract

Educational systems today often fail to imbue students with an interest or value for learning. Students in underprivileged areas disengage in education at young ages and are unlikely to pursue STEM education and careers. The purpose of this project is to engage marginalized youth in STEM education through the use of an immersive narrative experience called a "Mystery Room." Through analysis of students' perception of time, verbal feedback, and behavioral observations, we determined that this strategy successfully captures student interest and has a significant effect on STEM engagement. Our findings are intended to assist educators in implementing active learning to engage students.

## Acknowledgements

Our team would like to thank our project site sponsors, Edgar Caballero and Jonathan Chee, for all their guidance and assistance. We are incredibly grateful to them for the extensive amount of time and energy they committed to this project, and the patience and kindness they showed us. Without their sense of imagination to inspire us, and their sense of reality to guide us, we could never have actualized the dream of the Mystery Room.

We would also like to thank Christie Sinclair and Monica DiSanto for their roles in helping us build and run the mystery room. Christie, as Banksia's WorkSkills Coordinator, was instrumental to our ability to construct challenges. We appreciate his involvement in the design and manufacturing of room elements, as well as his patience and generosity in allowing us to use workshop tools and space. Monica DiSanto assisted us behind the scenes each week, helping ensure the cinematic effects of the mystery room worked successfully and functioned to accentuate the narrative.

As our project was in a community service center, it would be neglectful not to attribute a share of the success of this project to the community. The Banksia staff members were always kind and receptive to us, and generously donated their space to our team's project. We would also be remiss not to thank our participants themselves, the students of the Banksia Gardens after school program, for their role in helping us determine the effectiveness of our mystery room, and for their feedback on how we could improve for future studies.

On the academic side, we express our appreciation to our advisors, Professors Herman and Brigitte Servatius, from Worcester Polytechnic Institute, for the hours spent revising this report, and providing weekly feedback on our progress and direction. Their guidance contributed to rich discussions which truly helped shape our project experience.

We thank both Worcester Polytechnic Institute and Banksia Gardens Community Services for this amazing opportunity. The chance to contribute to the lives of those around us and to conduct research which will foster further exploration has been a remarkable experience.

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## 1 WPI and the Banksia Gardens Mystery Room Project

In an ideal world, all students would have equal levels of academic motivation and opportunity, leading to equal levels of achievement. Realistically, students face challenges both outside of school and in the classroom which can hinder their ability to succeed.

Recent Australian studies cite a pronounced achievement gap between low-income and high-income students ([Remeikis, 2018](#)). The inequitable distribution of wealth and resources can hinder a child's ability to succeed within the education system. The Banksia community, located in Broadmeadows Victoria, is one of the most disadvantaged neighborhoods in the metropolitan Melbourne area ([Hume City Council, 2018](#)). Students do not feel engaged in the classroom, which leads them to be disconnected from what they are learning ([Subban, 2016](#)). A lack of engagement in school affects knowledge retention, performance, and motivation among students ([Mastascusa, 2011](#)). This low engagement translates into a low academic achievement rate, and a higher likelihood of dropping out. This problem is especially pronounced when examining achievement in science, technology, engineering, and mathematics (STEM) topics.

To solve this issue we addressed the connections between student engagement and value. The premise of our study relies on the theory that student achievement is being affected directly by engagement, which is rooted in the motivation of the individual. Banksia Gardens Community Services has asked us to develop multiple iterations of an immersive learning activity called a "mystery room" or "escape room" (used henceforth interchangeably). The mystery room activity employs STEM-themed puzzles in the context of a narrative experience to promote engaged learning. The artistic nature of the mystery room creates an alternative approach to conveying technical topics. Using art to teach STEM activates both sides of the brain. This enhances student learning and gives students the opportunity to use creative means to solve STEM problems ([Daugherty, 2013](#)). Our goal was to address the current lack of engagement by using an immersive mystery room activity to facilitate participation in the STEM puzzles in an environment that promotes collaboration and enhances problem solving skills.

The mystery room promotes engagement through its use of active learning strategies. Active learning strategies, where students are involved socially or tangibly in the learning

process, are demonstrated to engage students more effectively than traditional methods ([Freeman, 2014](#)). Mystery rooms implement this concept through their use of hands-on problem solving. The room's STEM-based challenges were designed to maximize student engagement and allow an opportunity for hands-on learning, with the goal of engaging them in STEM. Active learning is an effective way to foster engagement in STEM topics amongst youth.

This project was founded on our research of the Banksia Gardens Community Service Center and the Broadmeadows area, motivational and cognitive models related to this age and demographic group, the methods behind mystery rooms, and STEM curricular ideals and standards. For information relevant to our specific project, we investigated the two previous project groups which developed mystery rooms for Banksia, to learn from their successes and failures. To ensure we create an environment which suits our participants, we have researched and incorporated techniques on working with students with traumatic backgrounds, as many participants come from situations of domestic abuse or of civil turmoil. To better design a challenge appropriate for the cognitive level of our audience, we developed a more personal understanding of our intended participants through our work with the Banksia after school program. The information we learned through this research was used to create a more effective educational experience.

We used observations, surveys, and focus groups in order to investigate interest and values of STEM among the participants and determine the extent to which we effectively influenced student motivation. To obtain a baseline for our participants' motivation, we distributed surveys to the children to gain a sense of their interests and values. To make the connection between the mystery room puzzles and STEM topics, we have given the participants an opportunity to explore the concepts and expand on their experiences by playing with the puzzles without a time constraint. Here, they can more fully understand how they work and spend some time learning the concepts on their own terms. This opportunity allows them to learn the STEM concepts behind the puzzles and connect abstract ideas with real life examples. In the days following the mystery room activity, we administered the same survey to see if their interests and values of STEM compared to other subjects has shifted as a result of the mystery room activity. To supplement the surveys and more directly measure engagement, we examined



students' perception of time while they were in the room. Immediately upon exiting the room, we asked students their age and how long they felt they were inside, and recorded their data to compare to the actual time spent in the room. The more engaged a participant is, the more inaccurate their perception of time should be ([Cohen, Henin, & Parra, 2017](#)). Finally, we facilitated a focus group discussion after each iteration of the mystery room that will help us determine the success of the room. The focus groups will contribute to our assessment of the room's success. The students' feedback should give us an idea of how involved they were in the concepts and how much interest was retained. Our research will guide us toward the creation of an immersive and engaging mystery room as a means to further education and motivate students to pursue careers in STEM fields.

## **2 STEM Engagement in Unengaged Youth**

Every year, parents enroll their children in schools with hopes to educate them and promote a more successful future. Schools come in many forms including private, public, and homeschools. Each type of school shares a common goal of educating students and preparing them for a broad array of lifestyles and career trajectories. Schools standardize the introductory experiences of life and the expectations communities hold of certain age groups. However, some students do not have access to education due to a variety of factors including poverty and language barriers.

We define "the income gap" as the difference in yearly income between families in the 90th percentile and the 10th percentile of family income distribution. In Australia, where our study is set, not only is national academic performance decreasing, but it is decreasing by 50% more in the bottom portion of the socio-economic spectrum than it is in the top ([Remeikis, 2018](#)). The percentage of students who have not completed year 12 by age 19 is much higher in students with a low socio-economic standing, jumping from 26 percent to 40 percent ([Mills, 2016](#)). Researchers have hypothesized that the correlation between economic status and achievement might be due to affluent families spending more of their income on their children's education and extracurriculars ([Tavernise, 2012](#)). Social class has an impact on academic performance, and the marginalized youth in the Broadmeadows area may suffer as a result.

## 2.1 Banksia Gardens Community Services

The mission of the Banksia Gardens Community Service Center is to improve the lives of its surrounding community. In Banksia Gardens Community Service Center's words, their message is "Transforming Lives, Strengthening Communities, Reducing Disadvantage." They are committed to being leaders in education, training, and community engagement through opportunities for the disadvantaged. They are a semi-public organization funded through donations and government contributions. As of 2018 they have a budget of 1.2 million dollars which provides 5.7 million dollars worth of provided services per year. The Banksia Gardens Community Service Center is managed by a board of governance and has over 40 employees. Often the Banksia Gardens Community Service Center works with other organizations and volunteers in order to better provide helpful tutoring and learning experiences ([Brolliar, Cox, Oswald, & Williamson, 2018](#)).

The Banksia Gardens Community Services Center has one main building containing a childcare center, several classrooms for study groups and school courses, and an information technology room. In this building they run numerous programs for both adults and adolescents. These programs include: job-training, social skills such as communication with peers, computer programming, homework assistance, and lastly teaching them how to be independent in society. Each year around 80,000 people are helped by the programs ([Brolliar, Cox, Oswald, & Williamson, 2018](#)).

The Banksia Gardens Community Services Center offers additional programs targeted towards the local community. They offer hands on assistance through their homework and computer club. In the homework club, volunteers help children that need academic support. Often this club involves math tutoring, aid with reading, and support while creating STEM related projects. In their computer club, they allow students computer time in order to learn programming skills through coding games and tutoring sessions. The computer lab provides free internet to everyone, making it physically accessible as well as intellectually accessible as the computers are loaded with academic resources and games. Additionally, the clubs help children develop social and emotional skills through recreational activities such as sports. This

opportunity allows youth to learn important technological skills that they might not have any other access to. All of the programs and clubs offered are designed specifically to create an active classroom and to keep students constantly engaged ([Broliar, Cox, Oswald, & Williamson, 2018](#)).

Broadmeadows is considered a disadvantaged area, as it has a lower employment rate than the rest of Hume City. Broadmeadows has an employment rate of 84.0%, compared to an overall employment rate of 91.3% throughout Hume City ([Hume City Council, 2018](#)). Another reason it is considered disadvantaged is because of the diversity in language. In Broadmeadows, 59.9% of people speak a language other than English at home. A number of other languages are prevalent in the Broadmeadows area, including Arabic, Turkish, Assyrian, Urdu, Vietnamese, Nepali, and others. Only 29.0% of Broadmeadows residents speak English only, as compared to 49.4% throughout Hume City. 14.3% of residents in Broadmeadows do not speak English well or at all, whereas 8.1% do not speak English well throughout Hume City ([Hume City Council, 2018](#)). A combination of low social class due to unemployment and diversity in language within the area makes Broadmeadows a disadvantaged area and makes it more challenging for the youth to receive an education.

Much of the challenge in the situation faced by impoverished youth is not in the concrete barriers to success, as one might imagine, but the lack of educational preparation and encouragement throughout a child's life, starting as early as infancy. Learning that occurs early in childhood relies on simple pattern recognition. Before a child ever enters the educational system, they learn through exposure to different social environments and experiences. Even with as simple a concept as the number of words addressed to a child, children of American families on welfare in some cases hear only  $\frac{1}{3}$  of the words children in affluent families do. These tenuous beginnings determine a trajectory for a child which is increasingly difficult to correct ([Lew-Williams, 2016](#)). Banksia Gardens Community Services Center understands the effects these experiences can have on students and their educational career, and thus seeks to channel methods from educational models to create successful students.

Many if not all students encounter unique challenges outside of school. These can range from being stressed or anxious about a specific traumatic event. An effective way to explain this

is through the Berry Street Education Model. The Berry Street Education Model is an education initiative that provides resources to schools to help engage all students, especially those most disengaged. There are three main pillars of this model. The first being that it is trauma-informed, meaning that it focuses on healing self-regulatory abilities of the body and emotions, and healing one's ability to form long lasting relationships. The second pillar is based on positive psychology and the teaching of a growth mindset, giving the resilience needed to face anything life has in store. The final pillar is academic growth. Students need to feel that their time in school is well spent and that all of the effort they have put in has paid off ([Berry Street Education Model, 2017](#)). All employees of Banksia Gardens Community Center have been trained on this model.

## **2.2 Escape Rooms and Narrative Adventures**

The use of games and puzzles has been shown to increase student participation and engagement. A professor named Martha Byrne conducted a study in which her undergraduate mathematics students played games and explored the mathematics that made them possible. Byrne reported that the games allowed her students to show elements defined as the foundation for mathematical inquiry. The elements discussed are conjecture, experimentation, creation, and communication (Byrne, 2016). Students used their interest in games and were able to connect this with educational principles. The students remained engaged while learning mathematical concepts, thus demonstrating the value of games and puzzles in the classroom.

Another set of studies concluded that students who played educational games scored higher on tests. In the studies examined, a group of business students were given access to a simulation business game, which allowed them to observe outcomes as factors were varied. Students who played the game felt more connected to their learning, as one participant commented; “in the game, it’s an experience that really stays with you, you actually learn...” ([Blunt, 2009](#)). These students averaged approximately ten percent higher on test scores than the traditional methods control group. Similar or even greater gains were seen in other studies explored in the article. In these studies, video games were implemented for educational purposes to improve comprehension and retention of information. We have built upon this idea, combined

with the elements of active learning previously mentioned, to create an immersive, kinesthetic learning experience which inspires students and bolsters academic success.

Escape rooms are “live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time ([Nicholson, 2018](#)).” Escape rooms place participants into an immersive storyline. They encourage participants to participate in a series of tasks and experiments in order to uncover clues and keys that allow them to escape from the fictional situation that they have been placed in. These activities have become increasingly popular. Though the first escape room was created just 11 years ago, there are now 4,785 escape rooms found across 75 countries ([Stone, 2016](#)). Escape rooms are starting to be incorporated in the classroom as a means to create a more interactive learning environment than a traditional classroom setting. These activities help students learn by increasing engagement, allowing students to apply their knowledge, and improving problem solving and teamwork skills.

Participating in escape rooms allow students to apply their knowledge in a setting that encourages problem solving and critical thinking. The process of applying knowledge improves students’ ability to retain information according to a 2011 study. The study showed that physics students demonstrated a 38% improvement in their understanding of kinematics when exposed to an active teaching approach as opposed to a traditional teacher-centered approach ([Stone, 2016](#)). Escape room participants can apply knowledge in order to complete experiments and tasks that assist learning. Tasks can be tailored in order to match the concepts covered in the classroom. Tailoring the concepts of the escape room can allow teachers to promote student retention in desired areas. Increasing student retention further demonstrates the educational value of escape rooms.

Escape rooms help participants to develop problem solving and teamwork skills. Participants work in small groups in order to complete the tasks with a common goal of escaping the room. Working in groups has been shown to improve student learning. Students learn better in groups because collaboration allows students to communicate their ideas with one another. Less skilled students learn through discussions with more highly skilled students. All students can improve through discussions with other students who have different viewpoints and

perspectives on the topic ([Ho, 2018](#)). The process of collaborating with others is called interdependent learning. Interdependent learning facilitates educational discussions outside of the classroom and exposes students to new sources of information ([Ho, 2018](#)). Therefore, working with peers can improve academic performance among students. Escape rooms give participants the opportunity to work in groups and facilitate the comprehension of the covered material.

Escape rooms engage participants when they are run effectively and interactively. In order to create an effective game, players should be incorporated into the story. Players' choices should have implications that affect the outcome of the game. Puzzles and challenges should contribute to the storyline of the escape room, rather than becoming the primary focus. It is important to avoid creating a superficial escape room where a physical lock and key are merely used as a means to reward participants for completing tasks. In this sense, a key acts as a check mark from a teacher would in a classroom. This style of activity is superficial because the solving of the puzzles is not incorporated into the narrative. A superficial activity would provide no more benefit than a traditional classroom setting ([Nicholson, 2018](#)). Instead of using locks and keys, the solutions of puzzles should yield results that contribute to the storyline. The goal of an escape room is to create an activity that benefits the participants in a way that cannot be replicated in a traditional classroom. An effective escape room is created through the use of an engaging storyline and a commitment to a narrative in order to create an immersive experience.

Effective storytelling involves an immediate and personal interaction between the storyteller and the audience. The storyteller should use a variety of the five senses of the audience as a means to increase immersion (Mitchoff, 2005). Stories can be effective when related to personal interests or experiences of the audience. Incorporating interests and experiences makes a story more relatable to an audience by creating unique perceptions in their heads (Mitchoff, 2005). Utilizing these storytelling techniques in an escape room can make the narrative more believable and engaging for participants.

### **2.3 Educational Subjects and Strategies**

In approaching solutions to an educational system without equal opportunities for success among students, it is important to explore curricular expectations. The overall curriculum that

Australia currently follows was created in 2015 and has a specific framework for the different age levels. Our target age group ranges from 6-15 years. In the state of Victoria this roughly translates to Years 1-8 ([Pressick-Kilborn, 2018](#)). With this new curriculum, the government in the state of Victoria is hoping to increase the amount of students in the top two proficiency levels of science from 10.0% in 2016 to 14.6% in 2025. This is one of their major STEM related educational goals ([Department of Education and Training Victoria, 2017](#)).

Since the purpose of the mystery room is to enhance the success of students in STEM subjects in Australia, the design of our room was informed by the Australian science curriculum frameworks. These frameworks helped dictate the objectives for each activity within the room. There are four major science topics that the Australian curriculum covers. These are biological sciences, chemical sciences, earth and space sciences, and physical sciences. In Year 1, biological sciences, they learn the concept that living things have a variety of features and that they live in different places based upon their needs. The concepts build off of each other each year and in Year 4 students learn that living things have cycles and that living things depend on each other and nature to survive. This further progresses to Year 8, where the students learn that cells are the basic unit of living things and that multicellular organisms contain organs with specific functions ([Australian Curriculum](#)). Figure 1 and Figure 2 outline the content covered in each major science area for our target age groups and corresponding years ([Australian Curriculum](#)).

Science	Content Covered	Year
Biological Sciences	Living things have a variety of external features	1
	Living things live in different places where their needs are met	1
	Living things grow, change and have offspring similar to themselves	2
	Living things can be grouped on the basis of observable features and can be distinguished from non-living things	3
	Living things have cycles	4

	Living things depend on each other and the environment to survive	4
Chemical Sciences	Everyday Materials can be physically changed in a variety of ways	1
	Different materials can be combined for a particular purpose	2
	A change of state between solid and liquid can be caused by adding or removing heat	3
	Natural and processed materials have a range of physical properties that can influence their use	4
Earth and Space Sciences	Observable changes occur in the sky and landscape	1
	Earth's resources are used in a variety of ways	2
	Earth's rotation on its axis causes regular changes, including night and day	3
	Earth's surface changes over time as a result of natural processes and human activity	4
Physical Sciences	Light and sound are produced by a range of sources and can be sensed	1
	Earth's resources are used in a variety of ways	2
	Heat can be produced in many ways and can move from one object to another	3
	Forces can be exerted by one object on another through direct contact or from a distance	4

Figure 2: Years 5-8 Science Content

Science	Content Covered	Year
Biological Sciences	Living things have structural features and adaptations that help them to survive in their environment	5



	The growth and survival of living things are affected by physical conditions of their environment	6
	Classification helps organise the diverse group of organisms	7
	Interactions between organisms, including the effects of human activities can be represented by food chains and food webs	7
	Cells are the basic units of living things; they have specialised structures and functions	8
	Multicellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce	8
Chemical Sciences	Solids, liquids and gases have different observable properties and behave in different ways	5
	Changes to materials can be reversible or irreversible	6
	Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques	7
	Properties of the different states of matter can be explained in terms of the motion and arrangement of particles	8
	Differences between elements, compounds and mixtures can be described at a particle level	8
	Chemical change involves substances reacting to form new substances	8
Earth and Space Sciences	The Earth is part of a system of planets orbiting around a star (the sun)	5
	Sudden geological changes and extreme weather events can affect Earth's surface	6
	Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon	7
	Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable	7

	Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales	8
Physical Sciences	Light from a source forms shadows and can be absorbed, reflected and refracted	5
	Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources	6
	Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object	7
	Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems	8

STEM is an acronym used in the context of both school and industry. When used in school context, it refers to the learning of these four major topics. When used in an industry context, it refers to the careers that focus on the four areas ([Marrero, 2014](#)). STEM is a way of thinking and not about science, technology, engineering and mathematics as individual subjects but as a whole. STEM requires students to identify a problem and create possible solutions that could be tested to solve the problem. It requires a student to think through a problem and engage with it ([Pfeiffer, 2017](#)). This way of thinking is important because new, creative ideas are continually needed to solve the world's everchanging problems. In 2015, the Australian government announced an agenda with the goal to encourage "all Australians- from preschoolers to the broader community- to engage with STEM ([Pfeiffer, 2017](#))." Within the last few years money has been put into STEM to fund new curriculums, train teachers, and provide professional learning programs. The goal is for STEM to be delivered in a way that encourages thinking, curiosity and the use of a procedural approach called the scientific method ([Pfeiffer, 2017](#)). Through the use of our mystery room, puzzles were used to encourage students to think about STEM and be creative in their use of the scientific method to solve the puzzles within the mystery room.

## 2.4 Strategies Used

When considering student development and factors behind student achievement, it is important to take into account motivation. In this project, we used student interests and values to define motivational change. Interest is an important motivational construct as it impacts the subjects students are most readily drawn to. While intrinsic interests cannot necessarily be changed, educators play an important role in shaping situational interest. Creating engaging and rewarding learning experiences which focus on effort and cooperation will boost situational interest and contribute to long-term motivational effects ([Prithwi, 2010](#)). We also looked into student values, or, what is important to students and what they believe is impactful in their future. This motivational tenet is based in Expectancy-Value theory, which posits that student academic trajectories are based by self-expectancy, costs, and benefits. Studies have shown that in some cases, the utility value of a subject such as mathematics can carry stronger predictive capacity than the student's thoughts and feelings on it ([Guo, 2015](#)). Put simply, if students believe a subject is important and valuable, even if they are not interested in it, they will be more likely to pursue higher level courses on that subject.

We used these models to assess academic motivation in participants both before and after participating in our room, using it as a rough metric for the success of our experiment. If we were able to increase student motivation, by creating interest and accessing values, then we have theoretically also enabled them to do better academically.

## 2.5 Active Learning and the Mystery Room

As society has recognized the need for more engaging classroom strategies, research has inspired transformation of the traditional classroom environment. Physics Professor Eric Mazur can personally attest to the value of some of these changes. When he first began lecturing at Harvard, he had trouble capturing students interest, and he described an overall “lack of learning and retention.” When he started asking students questions through electronic polling during class, or had them turn to discuss a question with a partner, he saw his learning gains double, then triple. The process prompts students to reason for themselves, rather than just absorb

information; “through the discussion with their peers, the students often become emotionally invested in the learning ([Anderson, 2014](#)).”

The educational system that exists around the world today is what we will call a traditional classroom setting. Traditional learning occurs in a setting of instruction in which “students are passive recipients of knowledge from an expert ([University of Minnesota, 2018](#)).” This can be compared to active learning settings in which students are encouraged to engage in learning through the use of activities, collaboration, and problem solving ([University of Minnesota, 2018](#)). Teachers in a traditional setting often give lectures and verbally teach concepts to students. Hence, non-traditional classroom settings include environments in which teachers’ lectures are not the primary source of information for the students. The primary source of information may include games, activities, or other strategies that facilitate learning through collaboration and debates ([Konopka, 2018](#)). Traditional learning styles are causing a global problem because they are not significantly engaging students in STEM subjects ([Mastascusa, 2011](#)).

The process Professor Mazur explored in his classroom is known to the educational community as “active learning.” This term’s strict definition varies, but it generally encompasses “the process of acquiring knowledge, skills, values and attitudes by any educational strategy that involves or engages students in the process by leading them to activities and debates ([Konopka, 2018](#)).” In a 2014 study done on active learning in STEM classes, researchers meta-analyzed hundreds of studies to compare the success of active learning versus traditional lecturing strategies. The study found that not only did students in active learning classes receive on average half a letter grade higher, but they found that students in traditional classes were one and a half times more likely to fail. These findings held true across STEM disciplines and across all class sizes (though are more effective in small classes) ([Freeman, 2014](#)).

Mystery rooms are an example of an active learning environment. These rooms utilize active learning strategies in order to help the participants maintain engagement and can be tailored to convey educational topics. Active learning has been shown to increase engagement and performance, so a mystery room activity can be an effective way to convey a passion for

STEM topics ([Freeman, 2014](#)). The benefit of active learning activities such as mystery rooms is that they provide an interactive learning experience for participants.

### 3 Creating an Immersive Experience

The original goal of our project was to design and develop two different mystery rooms to engage the youth at Banksia in STEM topics. Though this goal remained constant throughout the project, the methods behind this process evolved over the course of the term.

When we arrived at the project site, we found that our sponsors had reconsidered some of the details of our resources and constraints. One of the largest changes was the decision to not hire an actor. Whereas last year's immersive experience was guided by a non-student character in the room, this year the center decided not to hire an actor in order to make the room easier (and cheaper) to run again in the future. As a result of that change, the room design became significantly more complicated to account for automation, and the schedule for building the room was forced to expand. Once construction of the first room was underway, we came to an agreement with our sponsors that it would be more efficient and more realistic to build one room with multiple iterations than build an entirely new room.

#### 3.1 Materials Required

Once the room was designed, a list of materials was made with estimates of how much it would cost for the building of our room. The initial budget was approved at around \$450, around \$60-\$120 per category of item. This budget included items such as wood, wire, duct tape, spray paint, oil, and food dye (Figure 3).

What system	Item	Amount (By Package)	Cost	Total Cost
General	Wires	2	\$5.50	\$11
	speaker	3	\$0.00	\$0
			<b>TOTAL</b>	<b>\$11.00</b>
Mechanical	Motor	1	\$0.00	\$0
	Switch	1	\$10.00	\$10

	LEDs	2	\$0.00	\$0
	Wood to build gears	1	\$19.00	\$19
	Wooden Dollies	1	\$2.00	\$2
	Washers/nuts	6	\$0.50	\$3
	Wood to mount gears	1	\$20.00	\$20
	Shaft extender pieces	2	\$13.00	\$26
	Plywood backboard	1	\$25.00	\$25
	2x4	2	\$5.00	\$10
			<b>TOTAL</b>	<b>\$115.00</b>
Electrical	Alligator Clips	3	\$7.11	\$21
	Back Board	1	\$10.00	\$10
	LED	1	\$0.00	\$0
	Computer Mini Fan	3	\$10.00	\$30
	Battery	1	\$5.00	\$5
	Diode	1	\$0.00	\$0
	Resistor	1	\$0.00	\$0
			<b>TOTAL</b>	<b>\$66.33</b>
Chemical	Vegetable Oil	3	\$5.00	\$15
	Food Coloring	1	\$0.00	\$0
	Water		\$0.00	\$0
	Alka-Seltzer Tablet	2	\$10.00	\$20
	Dish Soap	2	\$3.00	\$6
	Erlenmeyer flask 500ml	3	\$7.00	\$21
	tray	2	\$8.00	\$16
			<b>TOTAL</b>	<b>\$78.00</b>
Ambiance	"Emergency" LED	1	\$15.49	\$15
	Metallic Green Spray Paint	1	\$14.90	\$15
	Metallic Silver Spray Paint	2	\$14.90	\$30
	Acrylic Paint	3	\$2.20	\$7
	Paint Brush(es)	2	\$5.00	\$10
	"Vents"	6	\$10.20	\$61
	Floor Fan	1	\$39.00	\$39
			<b>TOTAL</b>	<b>\$176.99</b>
Pre-room	cornstarch	2	\$4.00	\$8.00

	water		\$0.00	\$0.00
	food coloring		\$0.00	\$0.00
	bowls	2+	\$0.00	\$0.00
	Speaker		\$0.00	\$0.00
	Projector		\$0.00	\$0.00
			<b>TOTAL</b>	
			<b>TOTAL</b>	<b>\$455.32</b>

Figure 3 - Initial Budget

Once construction started, we realized we had incorrectly understood what tools and supplies Banksia had. While the cost for the mechanical challenge went down, the cost of the electrical challenge went up. An updated budget was created to reflect the changes we encountered (Figure 4). A side by side comparison demonstrates the change in the budget (Figure 5).

What system	Item	Amount (By Package)	Cost	Total Cost
General	Wires		\$0.00	\$0.00
	Duct Tape	3	\$3.85	\$11.55
	Speakers		\$0.00	\$0.00
			<b>TOTAL</b>	\$11.55
Mechanical	Wood		\$0.00	\$0.00
			<b>TOTAL</b>	\$0.00
Electrical	Alligator Clips	1	\$2.80	\$2.80
	LEDs	3		\$50.87
	Transistors	10	\$1.50	\$15.00
	Vent	1	\$5.72	\$5.72
	Fans	3	\$0.00	\$0.00
	Batteries	2	\$5.48	\$10.96
	Buttons	8	\$0.99	\$7.92
	Big LED	1	\$9.85	\$9.85
	Switches	6	\$2.50	\$15.00
	Big Buttons	4	\$1.95	\$7.80
	Crimp Heads	3	\$0.00	\$0.00

				\$125.92
Chemical	Vegetable Oil	3	\$4.40	\$13.20
	Food Coloring	1	\$0.00	\$0.00
	Water		\$0.00	\$0.00
	Alka-Seltzer Tablet	2	\$8.00	\$16.00
	Dish Soap	1	\$2.00	\$2.00
	Erlenmeyer flask 500ml	3		\$30.95
	tray	2	\$5.00	\$10.00
	<b>TOTAL</b>			<b>\$72.15</b>
Ambiance	Black Spray Paint	2	\$8.15	\$16.30
	Grey Spray Paint	5	\$8.15	\$40.75
	Acrylic Paint		\$0.00	\$0.00
	Paint Brushes		\$0.00	\$0.00
	<b>TOTAL</b>			<b>\$57.05</b>
Pre-room	ECE Kit		\$0.00	\$0.00
	Mech Kit		\$0.00	\$0.00
	Chem Kit		\$0.00	\$0.00
	<b>TOTAL</b>			<b>\$0.00</b>
			<b>TOTAL</b>	<b>\$266.67</b>

Figure 4 - Final Budget

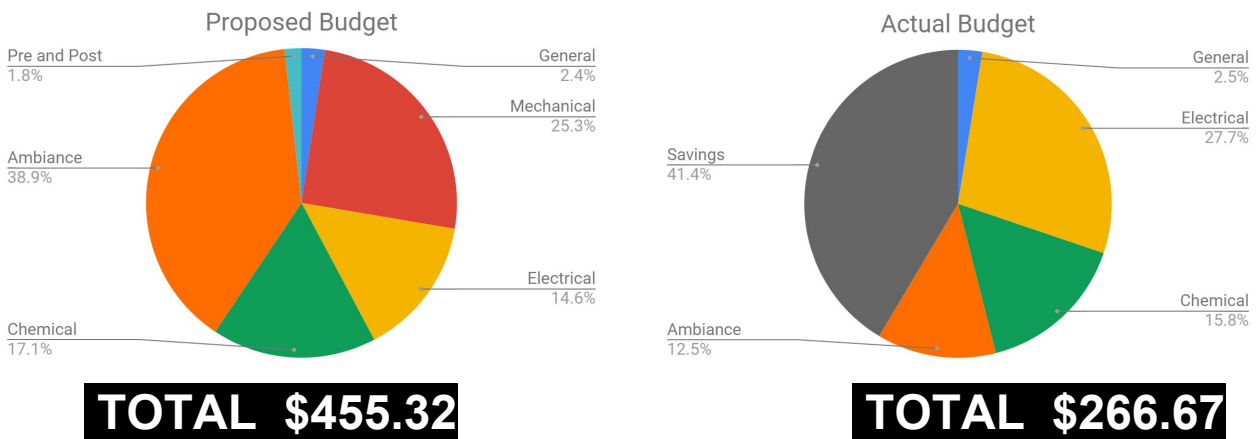




Figure 5 - Side by Side Budget Comparison

### 3.2 Schedule

Our intended timeline for this project included the production and analysis of two mystery rooms over the course of an eight week term. Each room was expected to take a week and a half to two weeks, including time for ordering and purchasing parts. Before construction began on the room, we intended to administer surveys to after school program participants to gauge their interests and values. This first week would be spent subjectively assessing students' cognitive and academic levels to determine how difficult to make the challenges. During the second (and fourth) week, mechanical construction would occur concurrently with programming and electrical engineering, based on when parts become available and when structural components are finished. After the completion and run of the room, focus groups would be conducted, surveys re-distributed, and conclusions drawn thereupon (Figure 6).

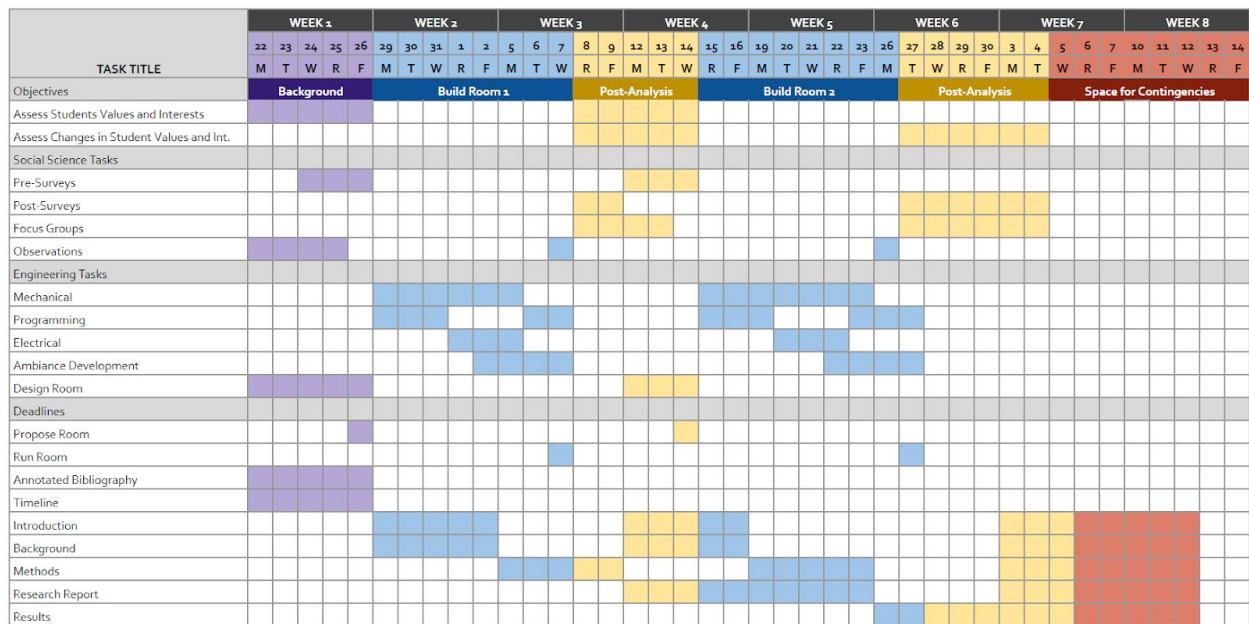


Figure 6 - Initial Gantt Chart

Our actual timeline was altered significantly because of the decision to exclude an actor and shift our focus to the creation of a single room. The build process itself ended up taking three and a half weeks in total. Much of this was due to unforeseeable delays in obtaining parts and

inherent flaws in resources and materials. The mechanical construction of the room went faster than expected due to the past building experience of one of our team members, and the plentiful resources and tools provided by the Banksia Gardens workshop. Conversely, the electrical construction of the room was slowed by the lack of/quality of electrical resources and tools in the workshop, and by the unexpected need to order parts. The artistic backdrop of the room used low-cost and low-quality materials. These materials, paired with a lack of storage space, some parts were damaged by rainwater and by the careless handling of non-team-members. This slowed building slightly due to the need for periodic repairs to the materials in the room. Overall, it took one week to prepare to build and and finalize our designs with the available materials, three and a half weeks to build the room, three weeks to run the room once per week, and one concluding week to analyze the data and develop the report and presentation (Figure 7).

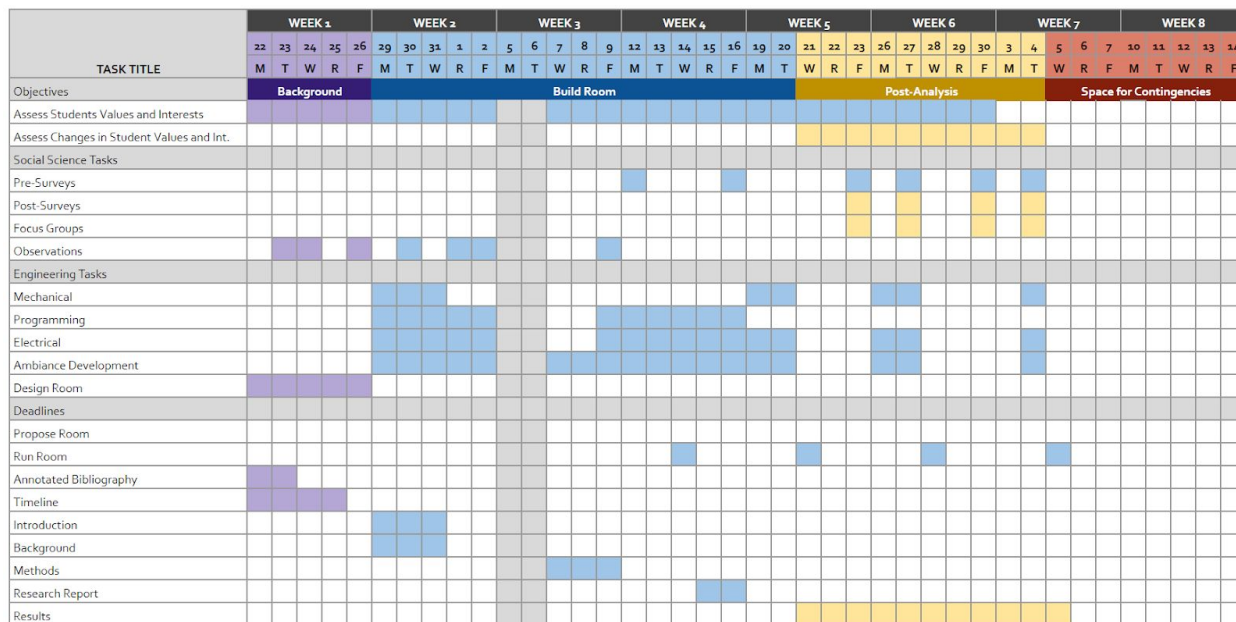


Figure 7 - Final Gantt Chart

The build process of this room would have been greatly simplified if we had been aware of the quality and quantity of resources available to us when starting. For future rooms, we would recommend asking for specific details on parts or tools required, if possible.

### 3.3 Working with Students

To get an idea of the students we were building the mystery room for, we volunteered in the homework club after schools on Tuesdays, Wednesdays and Fridays. This helped us to get a better idea of our target audience and make sure that the room we were building was suitable for the kids. While we volunteered, we observed the types of children we were working with, and noted their various academic levels, behavioral issues and other factors.

Overall, the kids were bright, energetic, and excited to learn. These attributes each came with their strengths and drawbacks. While the students were energetic, they were also rambunctious and easily distracted. Because of this, getting students engaged in learning was surprisingly easy, but keeping their attention required significant effort and creativity. Through working with them, we developed a sense of how long our pre-room and post-room videos could be, and in what order we would need to conduct activities to minimize distractions.

In working with the children at the after school program, we discovered that in order to reach all of our target audience, we would need to appeal to students in a variety of ways. What we had researched on the demographic background of the region was accurate, as described in [Section 2.1](#), and through interacting with the kids we determined ways to account for some of these disadvantages in our design. Some of the children who struggled with english as a second language might need hints or instructions in the form of pictures instead of words. Other children who struggle with attention disorders (or are simply distractible) might require more frequent prompting to stay on task. This type of information helped shape the format of the challenges and hints in the mystery room.

### 3.4 Actual Building

The building of this mystery room largely depended on accessibility of materials, tools, and the use of shop skills including measuring, using power tools, drilling, and sanding. The bulk of the materials used in building this mystery room included wood, fasteners, LED lights, wires, and cardboard. The vast majority of the materials needed were located onsite in Banksia's

workshop. Any other materials were obtained at a local hardware store or through online ordering. Banksia's workshop also contained all of the tools needed for the cutting, drilling, and fastening required during the building of each challenge. The building of the room took into account the minimal storage space at the facility. All frames were designed to be disassembled or collapsible in order to use less storage space. The frames for the challenges include four bolts on each that can be removed so that the frame disassembles. The cardboard backdrops were supported by vertical wooden planks. Each plank was attached by a hinge to a wooden piece that acts as a kickstand. The hinged kickstands allow for the cardboard backdrops to stand on their own without additional support, and allow the frames to lay flat during storage. For specific details on what items needed to be built to create the mystery room, see our Operations Handbook, [Appendix C](#). A similar mystery room can be developed in the future if there is adequate access to resources and if team members have some shop skills and experience building.

## **4 The Reality of Fantasy**

After completing the initial building process, our ideas about the mystery room started to become a reality. The general theme is an alien spaceship crash landing with three main objectives for the team of participants to repair. The first objective is to fix the reactor core in order to restore the ship's power. This was an activity in which students could mix liquids and explore chemistry (Figure 8). Once power is restored, the second objective is to start the engine. In this activity, the team rearranged gears until they were in the most efficient order. The goal was to use the least force in the leftmost gear in order to create the most motion on the right. This challenge allowed students to learn about gear ratios and learn how mechanical engineers create efficient engines (Figure 9). Once the engine is started and power is restored, the ship should be ready for takeoff, however, the spaceship begins overheating. Hence, the third and final task is to activate the emergency ventilation system and start the fans in order to cool the spaceship. In this challenge, the team explored electrical engineering by completing a circuit (Figure 10). Once the room is set up with all of the challenges and ambiance, a team of staff members must operate the

room in order to make the experience a reality.

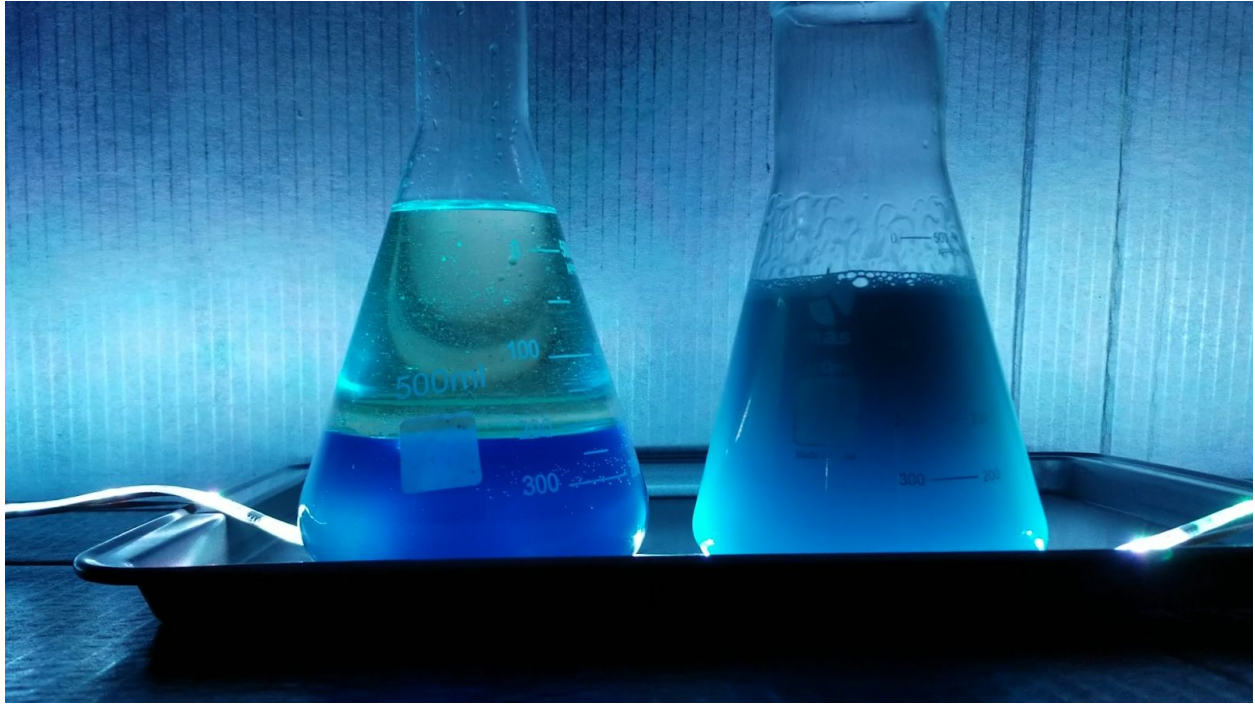


Figure 8 - Chemistry Challenge

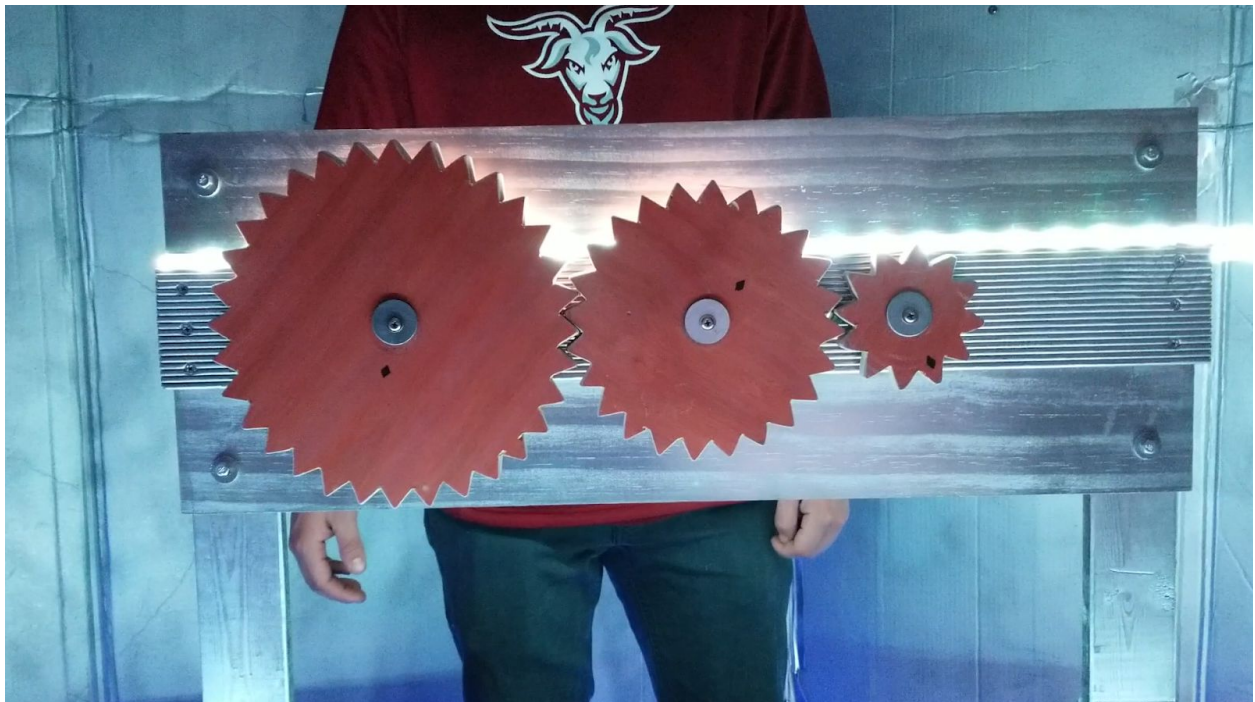


Figure 9 - Mechanical Engineering Challenge

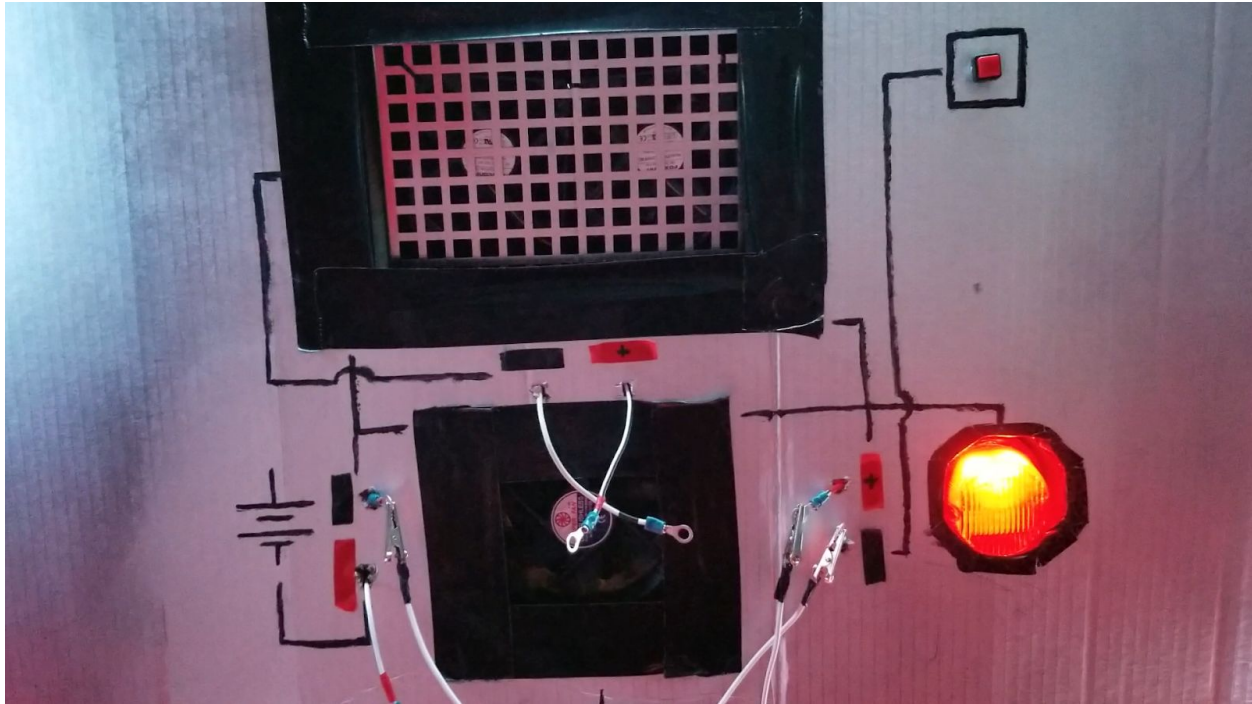


Figure 10 - Electrical Engineering Challenge

#### 4.1 Staffing

After completing three iterations of the mystery room, our team determined that we needed the help of three Banksia Staff Members in order to run the mystery room activity effectively. With our team of four, this included a total of seven mystery room operators. It's worth noting that operating the mystery room became more efficient with each iteration. With practice, it is possible to operate the room with only two operators in the mystery room itself, instead of the three we have described in [Appendix C](#), our operations handbook. The first operator is in charge of playing the video clips before and after the participants went into the mystery room. This operator also gives the participants their roles and badges. The second operator is in charge of creating the groups of participants that would enter the mystery room and guard the tunnel so that no children enter the mystery room when it is not their turn to enter. The third operator goes into the room with the participants to act as a supervisor and to manage the behavior of the participants. If needed, the supervisor can direct the mystery room participants and help with the challenges should the hints or lights malfunction, or if they are insufficient in order to allow the team to solve any of the puzzles. In the room, three operators are hidden

behind the backdrops of two of the puzzles. One operator was in charge of operating the lights through a control board. Another operator plays audio cues to direct the participants and help them to solve the challenges. The other operator in the mystery room watches the participants and communicates with the other two operators about what is occurring in the mystery room so that they can use the correct lights and play the correct audio. The last operator is located in a separate room with the activities with which the participants play with after they leave the mystery room. This operator shows the participants how to use the puzzles and activities and helps to reinforce the STEM concepts. The concepts are reinforced in order to translate engagement in the mystery room into an engagement in STEM.

## **4.2 Operating the Room**

The means of operating the room changed based on the circumstances we were placed into. The initial plan was to have an actor give the plot of the mystery room and direct the participants to each challenge; a structure similar to past mystery room IQP projects. However, the Banksia staff expressed concerns with the cost and feasibility of replicating the activity if it relied on an actor. Therefore, our team's solution was to automate the room so that the participants could understand the narrative and sequence without the aid of an actor. Automation included the implementation of programmable LED's and pre-recorded verbal hints and instructions that could be played over a speaker by a room operator. The combination of lights, hints, and instructions allowed the participants to progress through the mystery room without the need for an actor. Another adjustment we had to make was to record our own clips that detailed the plot behind the mystery room. Our team developed a series of drawings in a storyboard format paired with a script as a means to convey the story. We also recorded clips of ourselves acting as government officials who delegated tasks to the participants and gave them instructions on how to proceed through the mystery room. We ultimately replaced the need for an actor through the use of visual and aural automation. Operating the room in the future requires a small amount of practice with using the control board for the LED light strips. Otherwise, those who would like to complete this mystery room activity can replicate it without much technical

expertise besides the ability to play the video clips on a projector and to connect a laptop to a bluetooth speaker for the audio cues.

### **4.3 Assembly and Disassembly**

Assembly of the mystery room activity typically takes about one hour for a team of four, however this time decreases with practice. Setup within the mystery room includes the three challenges, their cardboard backdrops, running the LED strips through the challenges, and connecting a laptop to a bluetooth speaker. Outside of the room, setup includes preparing the videos to be played on the projector, and setting up the activities for the participants to play with after they leave the mystery room. Resetting the room after a group runs through the activity takes less than five minutes, so the next group can be sent into the first room to watch the clips almost immediately. Disassembling the room takes about 30 minutes and involves removal of the LED's, folding up the cardboard backdrop, and moving all challenges and activities back to their respective storage spaces. The exact procedure for assembling and disassembling the room can be found in [Appendix C](#), our operations handbook.

## **5 Measuring Engagement**

To effectively measure the success of our room, we employed both quantitative and qualitative feedback-gathering methods. In our quantitative analysis, we administered surveys to students and collected feedback on time perception. In our qualitative analysis, we examined student involvement subjectively through observing their behaviors before, during, and after the completion of the room activity.

### **5.1 Quantitative Methods of Assessment**

To measure the quantifiable success of our room, we administered surveys to participants to determine any changes in their interests and values, and we collected data on time perception to directly measure engagement. Our surveys ([Appendix A](#)) collect information on what students like, and what students believe is important. We have chosen to focus on these two metrics based on our research on psychological factors behind motivation and engagement ([Section 2.4](#)). The



surveys were formatted as a 1-5 Likert scale, which allows us to transform student's feelings from qualitative to quantitative data. Topics on the survey included each tenet of STEM as well as each challenge theme in the mystery room, mixed in with other non-STEM school subjects to prevent student bias. This was intended to measure lasting change to students' thoughts on STEM.

Our study of time dilation arose from our own research and from the experience of previous mystery room teams ([Section 1](#)). One study shows that engagement has an effect on time perception. When people are engaged, they tend to perceive their time involved in the activity as more or less than it actually was ([Cohen, Henin, & Parra, 2017](#)). We chose to analyze time perception to determine whether participants experienced a compression or dilation in their time perception as a result of engagement. Immediately after leaving the mystery room, we asked participants to write their age and the amount of time they felt they spent in the mystery room. We studied the results along with our qualitative observations of engagement. Though a compression in time perception can indicate either an abundance or lack of engagement, our team determined that the likely cause for the compression in time perception was caused by an increased engagement in the mystery room and the narrative. We reached this conclusion because we observed several instances of participant engagement through our observations during the mystery room activity as well as during focus groups.

## **5.2 Qualitative Methods of Assessment**

We collected a large quantity of qualitative information through focus groups and observations. Some of the most significant changes we observed could not be measured by numbers. Our observations were made somewhat less formally, but constituted a significant amount of our capacity to conclude on the success of the room. By noting student behaviors and verbalizations, we were able to determine interest and engagement directly. These observations allowed us to assess student engagement in the mystery room experience.

Many valuable observations were made while operating the mystery room. In the room, we could observe student interest in the ambiance and the puzzles and get a sense of the difficulty of each challenge. We could also observe if they understood the narrative and whether

our prerecorded hints were sufficient to allow them to complete all of the challenges. After each iteration of the room, the team debriefed and discussed notable observations that should be taken into account for the next iteration.

We also had the opportunity to assess student behavior in the post-room. Here, students could play with the puzzles from the mystery room and explore the science without a time pressure. Here, we observed the students' behavior including collaboration, retention, and engagement in the puzzles. Analyzing behavior in the post-room allowed us to assess short term engagement in the mystery room and the STEM puzzles. In order to assess long-term engagement, we observed the behavior of students who had completed the mystery room in prior iterations. Our goal was to see if the engagement resonated within the students and get a sense of their retention and engagement even after a few weeks.

To obtain further information on engagement and retention, we conducted several focus group activities to provide a comfortable environment for children to communicate their opinions of the room. Focus groups allowed us to learn about the effective and ineffective aspects of the room so that we could improve the room for future iterations. Focus groups were facilitated with children who returned to the study group in the days following the mystery room. We were only able to conduct focus groups for 9 of the 32 students who participated in the mystery room due to inconsistent attendance and time constraints.

## **6 Results**

A mystery room is an entertaining social experience for students that uses active learning strategies to engage students in a topic. This type of experience appeals to children's intrinsic positivity towards games and play. The mystery room we built was designed to translate interest in an engaging narrative into a STEM-based challenge. In our story, a spaceship has crash-landed in Broadmeadows. The aliens, a friendly and well-intended group of beings, need help in order to fix their ship so that they can make it to another planet for an annual family holiday. The team of students is sent in by the government with supplies to repair the spaceship. Students have to work together to repair the electrical, mechanical, and chemical systems of the ship to pilot the ship off Earth. Through this challenge we engaged the students in three aspects of STEM:

mechanical engineering, electrical engineering, and chemistry. We believed this would be engaging because the students have a direct impact on the narrative, and are drawn into the immersive environment.

The information presented here functions as an educational approach to solving the societal issues many students in Broadmeadows face as described in [Section 2.1](#). Between the disadvantages that low-income students grapple with during childhood, and thus the inherent motivational deficits it creates, students in the Broadmeadows area are in need of innovative educational strategies if they are to succeed academically and socially. Our intent in this project was to translate students' intrinsic goals and interests into a positive active learning experience. We ultimately used an immersive narrative to foster an engagement in the mystery room activity, and translated this engagement in the mystery room into an engagement in STEM, which we hope will motivate the youth to pursue STEM careers and education in the future.

## 6.1 Qualitative Observations

In each of the three iterations of the mystery room, youth engagement was immediately apparent. Before ever entering the room, children were excited to be involved. The students waiting to participate constantly asked questions about the mystery room experience and eagerly awaited their turn to enter. Children pounded on the door, climbed through gates, and peered in any uncovered window corner to gain access to the room. For these reasons, we had a staff member continually managing students outside the room, physically blocking the entrance until it was time to begin the experience.

Within the room, students were engrossed in the subject at hand and actively thought through challenges. Upon entering, students were visibly and audibly in awe of the spaceship environment. Many participants were vocal and expressive about their feelings on the room. They expressed amazement with the ambiance of the room and cheered when they completed challenges. During the first iteration, this curiosity led the children astray, and we had trouble getting them to listen to instructions for each of the challenges. During our second iteration, we learned how to channel this curiosity into a controlled focus among the group by redefining our

indicators, instructions, and challenges within the mystery room. Redefining the cues and challenges caused all of the teams to work together and complete each challenge in the sequence outlined by the narrative. Once the first LED indicator and audio clip played, participants immediately focused and shifted their attention toward the first challenge. Once we gained their attention and focus, we maintained it with verbal guidance through prerecorded audio cues. We also modified the other challenges so that they could not be completed until the previous puzzle was solved. This incorporated the challenges into the narrative and created a more controlled, collaborative environment that facilitates learning and allows students to participate in all challenges. During the mystery room, students pointed toward the flashing LED lights and announced the meaning of the color. For example, many students would say “Green! That means we did it right!” Others would cheer when they heard the bell that we played after they successfully completed each challenge. It was apparent that the visual and aural cues helped to guide the children through the mystery room. In the focus groups, we asked students if they noticed the lights and sounds. Almost all said that they understood the meaning of the cues and could recite them back to us.

Focus groups were valuable in other ways as well. The initial goal of the focus groups was to learn if our challenges were engaging and at an appropriate level for the participants so that we could make modifications for the next iteration (see [Appendix B](#) for question details). The results we got from the focus groups were actually much more valuable than we had anticipated. Children of all ages excitedly told us about how much fun they had during the experience and passionately explained how their favorite challenges worked. An overwhelming majority of the students could recite the major points of the narrative and demonstrated an understanding of their roles within the mystery room. Children often expressed that they identified with one or more of the challenges and generally understood the main STEM concepts behind these puzzles. One particular student decided to switch roles with our team as she drew on a white board and taught us about the science behind each of the puzzles. Members of the Banksia staff informed us that this girl is not engaged in school and only goes to the study group for the food. This was only the beginning of her transformation, as week after week she came back to the mystery room to help us operate, clean up, and teach the science concepts to other

children. It was a remarkable transformation and encouraging to see how the mystery room not only teaches STEM, but also collaboration, cooperation, and the value of helping others.

The participants expressed passion for the puzzles and continued to play with them both in the post-room activity and during their leisure time. In the post room activity students collaborated as they learned the concepts they just explored in the mystery room. In this room, they could freely explore the puzzles after learning the concepts in depth, and without having the time pressure created by the mystery room. If one of the students knew more about one of the puzzles than another student who was playing with that puzzle in the post room, the student who knew more about it would help teach their teammates how to do the challenge. During the second and third iterations of the mystery room, students who had participated in previous iterations still wanted to be involved with the mystery room, even though they were not allowed to go through the room again. Some of these students reentered the post-room in the following weeks and taught other participants about the science behind the puzzles. This demonstrated to us that the engagement resonated within some of these children long term. When it came time for the students to leave the post room, many did not want to leave and asked to continue playing with the puzzles. This demonstrates student engagement in not only the narrative, but the science behind each puzzle.

Some participants even helped us to run the mystery room in future iterations and eagerly participated in the post-room activities to help teach the new participants about the scientific concepts behind each puzzle. This was a notable observation because collaboration and teaching demonstrates active learning. Using active learning strategies helps students to learn and retain information, as detailed in [Section 2.3](#). This observation was particularly notable when typically unengaged students, as deemed by the Banksia Staff, expressed such a passion for the science behind each puzzle and helped to teach other students. Overall, the majority of participants openly expressed their engagement in the narrative and the puzzles while demonstrating active learning and retention of STEM concepts.

Many of the children gained a sense of pride and achievement that we had not predicted at the start of this project. As a small gesture, we decided early in our design process that we would give badges that said “Certified Engineer” to each of the participants who successfully

helped to repair the spaceship. Week after week, the students brought these badges back to Banksia and told us how excited they were to have them. Some wore the badges proudly on their chests, and others hung them up on their walls so they could look at them every day. This observation shows a benefit of the mystery room that we had not anticipated. Students were proud to have learned science and engineering. We feel that this pride will facilitate a confidence in learning STEM concepts that will increase their engagement and encourage them to pursue STEM education and careers.

## 6.2 Quantitative Data

To quantify our success in engaging students in STEM, we selected two objective measures of success: surveys and time perception. These were used to measure the impact of the room, their engagement in the room, and their engagement in the narrative, respectively.

## 6.3 Surveys

Our surveys had two main sections; participant interests and values. For overall value, students reported an average of 4.25 across 13 academic subjects. The subject with the lowest average value was physical education, at an average of 4.00. The subject with the highest average value was electrical engineering, at an average of 4.50 (Figure 11). Overall, the subject with the most number of “I Don’t Know” answers was tied between chemistry and biology, with 13 answers, closely followed by physics at 12 (Figure 12). For overall interest, students reported an average of 4.02 across 13 academic subjects. The subject with the lowest average interest was physics, at an average of 3.47. The subject with the highest average interest was chemical engineering, at an average of 4.46 (Figure 11). Overall, the subject with the most number of “I Don’t Know” answers was biology, with 17 answers, closely followed by chemistry and physics at 13 (Figure 13). This data set is created from the feedback from 30 students.

### Average Value Versus Interest by Subject

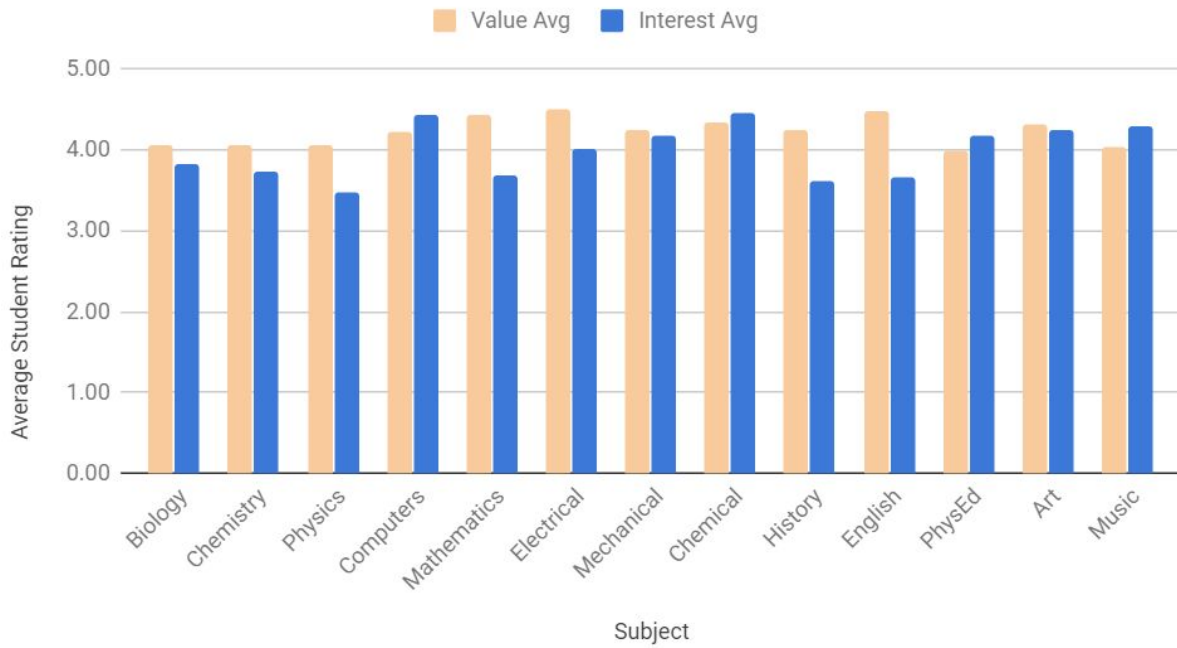


Figure 11 - Participant Values and Interests

### Number of Students Unfamiliar with A Subject (Value)

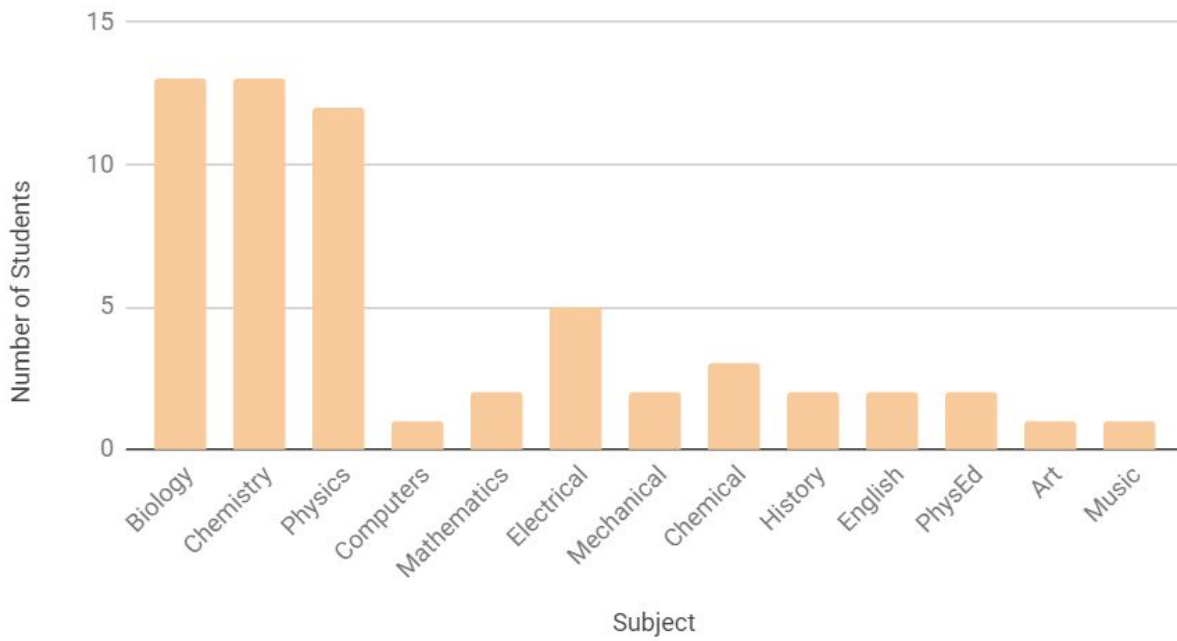


Figure 12 - Unknown Subjects (Value)

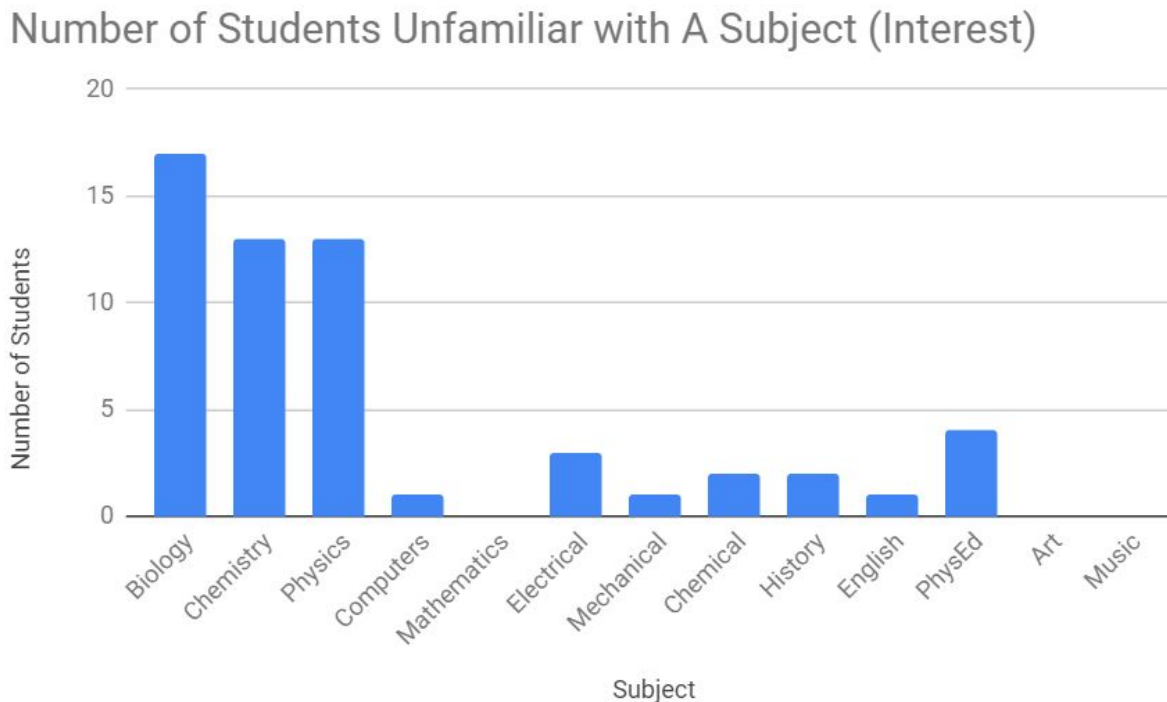


Figure 13 - Unknown Subjects (Interest)

When participants joined us later in the week for a focus group, we asked them to complete the same survey. We compared the results of the pre and post data sets to determine if the students' interests and values had changed. We divided the survey into three main sections: "STEM," which included mathematics and sciences, "Room," which included the themes of the three challenges, and our control group, which included subjects such as history, English, physical education, art, and music. This data set arose from the nine participants who were able to complete both the pre and post surveys. Data was analyzed on a scale of -5 to +5, -5 indicating a decrease by 5 points on the likert scale from the first survey to the second, and +5 indicating an increase by 5 points over the same time.

On average, interest in STEM subjects had a change of -0.6, room subjects had a change of -0.2, and control subjects -0.1. Value of STEM subjects had a change of -0.2, room subjects had a change of a-0.3, and control subjects showed exactly 0 average change.

The results of this before-and-after section, while included here, were considered invalid for the purpose of our conclusion. A cursory visual examination reveals that the data set shows



no obvious trends (Figures 14 and 15). The majority of students did not have a change in opinion by more than a single point, and there was no more obvious grouping of positive as opposed to negative change in any one area. As another indicator of significance, we paired each student's data with whether or not they believed that their answers were the "same" or "different" compared to the first version of the survey. These answers had absolutely no correlation to the data set, and oftentimes directly contradicted it.

Biolog y	Chemi stry	Physi cs	Comp uters	Mathe matics	Electri cal	Mech anical	Chemi cal	Histor y	Englis h	PhysE d	Art	Music	
-1	-1	-1	0	0	-1	-1	-1	0	0	0	-1	0	
			0	-1		1			1	1	-1	-1	same
	0	0	2.5	1	0	0	0	0	4	0	0	0	same
			0	0	0	0	0	0	0	0	0	0	same
0	0	0	0	0	0	0	0	0	0	0	0	0	different
1		-1	0	0	0	0	2	0	0	0	0	0	a bit different
-1	0	-1	0	0	0	-1	0	1	0	2	-1	1	a bit different
			-1	1	-2	0	-2	-1	1	0	-2	0	different
-1	0	0	0	0	-1	-1	0	0	-1	-1	0	-1	same

Figure 14 - Before and After (Value)

Biolog y	Chemi stry	Physi cs	Comp uters	Mathe matics	Electri cal	Mech anical	Chemi cal	Histor y	Englis h	PhysE d	Art	Music	
0	1	0	0	0	-1	-1	0	0	0	0	-1	0	
						1			1			-1	same
	-4	-3	-3	0	-1	0	0	-4	-1	-4	0	0	same
				0	0	0	0	0	0	0	0	0	same
			0	0	0	0	0	0	4	0	0	0	different
	0	1	0	0	0	0	0	-1	0	0	2	-1	a bit different
			0	0	0	0	0	2	1	0	1	1	a bit different
			1	0	1	0	-1	0	0	1	-1	1	different
-1	-1	-1	-1	-1	-1	0	-1	0	0	0	-1	-1	same

Figure 15 - Before and After (Interest)

Statistically speaking, a data set of 9 is too small to really be significant. Even assuming it was, a two-tailed unpaired t test of the data set as a whole yields a p-value of 0.7821 for “value” and 0.6194 for “interest,” which is not considered to be statistically significant.

We still consider the 30 pre-survey results to be of significance and interest, though they do not indicate student engagement or the success of the room. From these results, we were intrigued to discover that average student interest and value was high on average, and that students may understand or have heard of certain concepts, but did not necessarily associate it with an academic title.

## **6.4 Time Dilation**

To analyze the data collected we examined the amount of time they believed they were in the room (Figure 16), the difference or “dilation” (difference between that student’s estimate and that student’s room time), and the percent dilation (difference over actual time). The average time dilation for the whole group was 4.3 minutes, or 38.23% percent of the time that student spent in the room. Half of our participants experienced a time dilation of 43% or greater, with one quarter of participants experiencing a time dilation of about 60% or greater (Figure 17).

# Time Perception

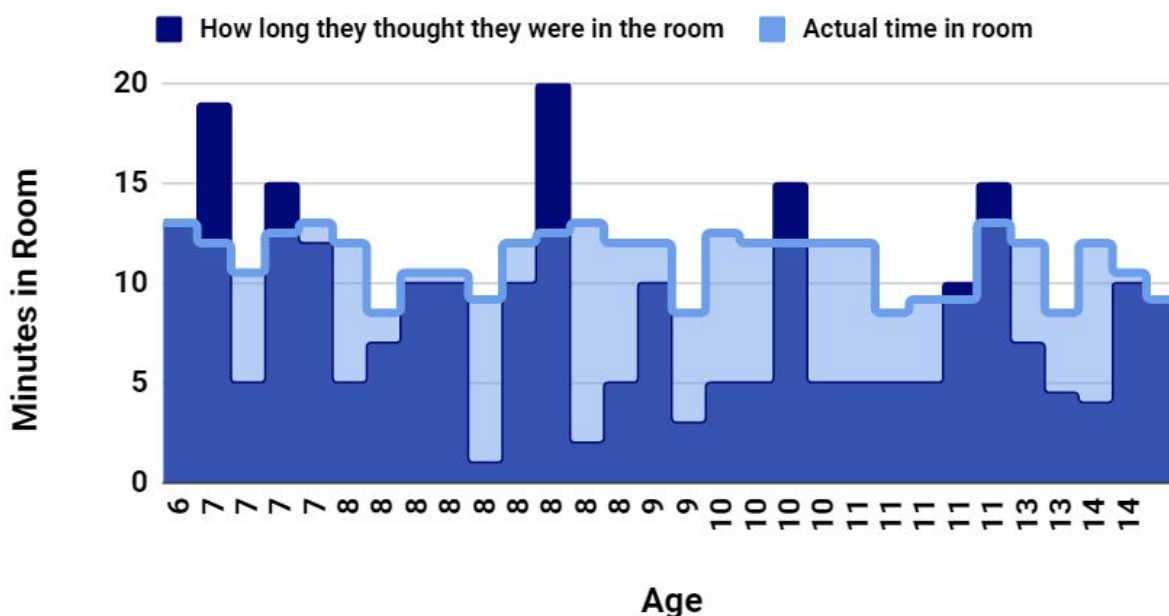


Figure 16 - Raw Time Dilation Data

## Percent of Participants Whose Time Dilation was Greater Than or Equal to X Percent

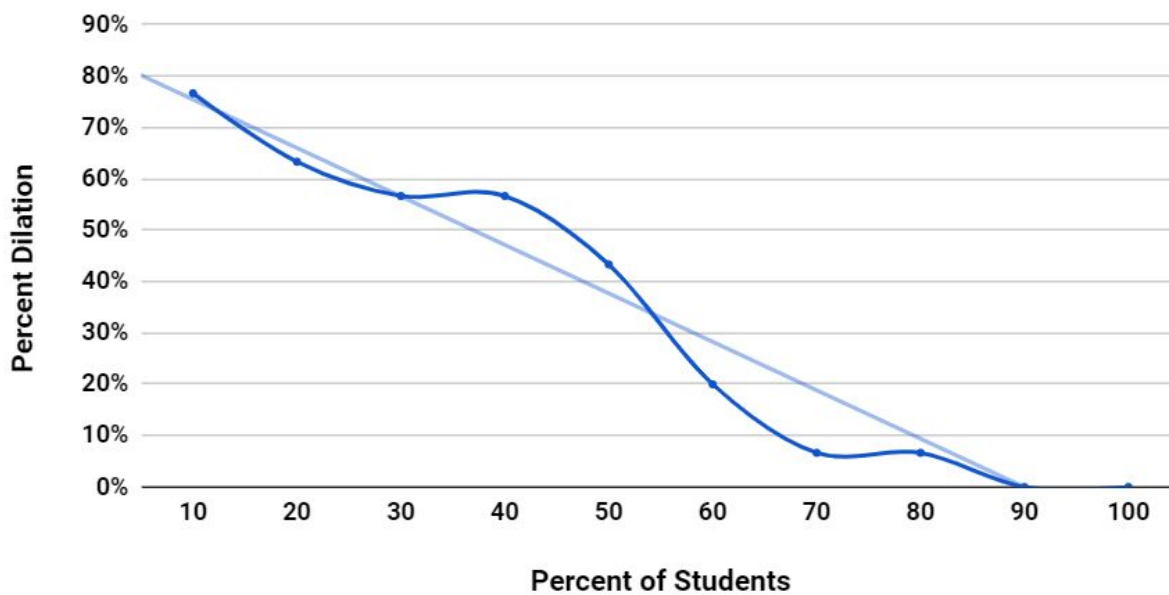
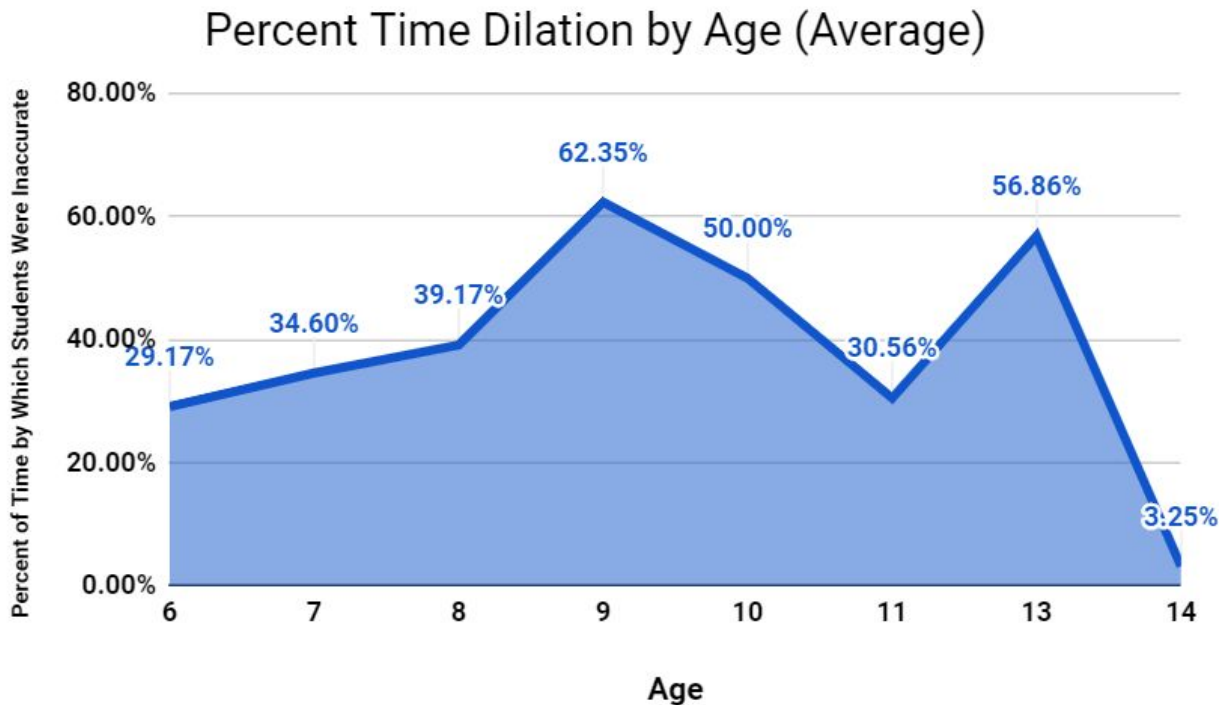


Figure 17 - Time Dilation Trend

The ages of the mystery room participants spanned from 6 to 14 years. Across all age categories, the group with the highest percentage dilation was 9 year olds, at 62.35% between 2 participants in that age category. The lowest engagement was seen in the 14 year olds, at 3.25% over 2 participants in that age category (Figure 18).



**Figure 18 - Percent Time Dilation by Age**

In terms of significance, it is important to note that our results may be biased by the tendency to estimate time in multiples of 5 (eg. 5, 10, or 15 minutes are more likely than 8, 4, or any other number). 50% of students provided an answer as a multiple of 5. Results may also be altered by the short timespan of the room; more significant results might be found if the room took place over a longer time span. Data is obfuscated here by the fact that a 10% dilation could translate to as little as a minute difference. 23% of participants gave answers within a minute of the correct answer, but as data was graphed on a continuous scale, this is not visually apparent.

If this were the only data we had collected about the room, we would not be able to draw conclusions, but when paired with our qualitative observations, we believe the results of our time dilation data are significant. The data suggests that the majority of students were highly engaged in the room overall, with students around age 9 showing the highest engagement.

## 7 Conclusion

The goal of this project was to facilitate an engagement in STEM topics amongst the marginalized youth within the Broadmeadows community. Our team was given the task of creating an immersive mystery room experience as a means to capture the interest of youth that may have less access to education due to personal background or social class. The long term goal of the project is to engage students in STEM topics so that they are more likely to pursue STEM education and careers in the future.

Our quantitative and qualitative analysis of the mystery room activity throughout the duration of the project suggests that the room was effective in stimulating engagement in STEM amongst the Banksia youth. Children were excited to enter the room and demonstrated an engagement in the narrative, as observed through our analysis of their distorted time perception paired with qualitative observations. While nine and ten year olds demonstrated the most time dilation, all age groups experience significant dilation. They also demonstrated a passion for the STEM-based puzzles in the mystery room, as many noted during our focus group discussions. The room promoted collaboration and communication amongst the participants, another valuable observation noted throughout the three iterations of the room.

Our findings throughout this report have broader implications than just STEM engagement in Broadmeadows. This project demonstrates the effectiveness of incorporating a narrative to promote engagement and retention. Using a mystery room to allow participants to experiment with STEM-based puzzles was an effective way to promote the use of active learning strategies including collaboration, communication, and hands-on application of scientific concepts. Another valuable observation was that nearly all students between the ages of 6 and 15 years found value in the same activity, thus demonstrating the effectiveness and flexibility of a mystery room to appeal to a wide range of audiences. We feel that mystery rooms can be used by teachers or others interested in stimulating STEM engagement amongst young people.

Though our mystery room was ultimately successful in achieving its goal, there are some areas that could be improved should someone want to expand on our findings and increase the effectiveness of the mystery room in the future. One of the primary concerns was the accuracy

and relevance of the results obtained in the surveys. The reason for concern is that children may give inconsistent results influenced by emotion or a lack of engagement in the survey. They often verbally expressed an increased interest in certain STEM concepts during our focus group discussions, though their surveys may have indicated a decrease or no change in engagement in the topic. The children also usually needed assistance in filling out the survey, so the lack of bias in the questions depended on the staff member who was helping the student complete the survey. Our survey intentionally contained few words so that it could be accessible to those even with low English proficiency. The best way to improve the survey is unclear to our team, yet we had great success in analyzing our qualitative observations. Therefore, we suggest removing the surveys from the mystery room to prevent inconsistencies in the results.

We would also recommend studying the mystery room's effects past the target age group at the target time. This study did not detail the effects of the post-room as compared to the mystery room activity itself, and from our qualitative observations we would say that this exercise appealed to different students than the main room, and in different ways. We also did not attempt to analyze long-term effects of the mystery room, and would suggest for further study that a year later these students be asked about our room again to determine the longevity of their increase in engagement.

The mystery room project requires a significant investment of both time and money, but based on our results we would conclude that it is a valuable activity with the capacity to have a lasting impact on disengaged students' impressions of education.

## References

[Anderson, J. \(2014, November 17\). The Benefit of Interactive Learning. Retrieved September 11, 2018, from https://www.gse.harvard.edu/news/14/11/benefit-interactive-learning](https://www.gse.harvard.edu/news/14/11/benefit-interactive-learning)

Physics Professor Eric Mazur can personally attest to the value of active learning. When he first began lecturing at Harvard, he had trouble capturing students' interest, and he described an overall "lack of learning and retention." When he started asking students questions through electronic polling during class, or had them turn to discuss a question with a partner, he saw his learning gains increase. The process prompts students to reason for themselves, rather than just absorb information; "through the discussion with their peers, the students often become emotionally invested in the learning."

[Australian Curriculum. F-10 curriculum. Retrieved from](https://www.australiancurriculum.edu.au/f-10-curriculum/learning-areas/)

<https://www.australiancurriculum.edu.au/f-10-curriculum/learning-areas/>

The Australian curriculum can be found on this page, from Foundation through year 10 through a range of subjects including science, mathematics, technology, art, and English. Within each subject you can select the years you want to look at such as science Year 1, and see a general overall description of the expected outcomes for that year and then the key topics learned. This website is very helpful for us to decide what STEM ideas or concepts we wanted to use in our mystery room. For example, year 7 is when the topic of mixtures and pure substances is introduced, we wouldn't want to use that idea in a year 3 group of students unless we give them some information prior to using that concept. This is important to know so that we do not make the puzzles within our mystery room too challenging for the children as that could discourage them and make them give up. This would not be an encouraging way to get the students more interested in STEM.

[Berry Street Education Model. \(2017, March 7\). Retrieved October 3, 2018, from](https://www.childhoodinstitute.org.au/focus-areas/berry-street-education-model)

<https://www.childhoodinstitute.org.au/focus-areas/berry-street-education-model>

This source was given to us by our sponsor and explains the Berry Street Educational Model. This source is the Berry Street Education Model official website. This model

describes a mentality with which to approach teaching so that students are prepared appropriately to be engaged in the classroom; “We focus first on building their capacity to engage and then nurturing their willingness to engage.” There are three main pillars of this methodology. The first is that it is trauma-informed, meaning that it focuses on healing self-regulatory abilities of the body and emotions, and improving one’s ability to form long lasting relationships. The second pillar is based on positive psychology and the teaching of a growth mindset, giving the resilience needed to face anything life has in store. The final pillar is academic growth. Students need to feel that their time in school is well spent and that all of the effort they have put in has paid off. All employees of the Banksia Gardens Community Services center have been trained on this model.

[Blunt, R. \(2009, December\). Do Serious Games Work? Results from Three Studies. Retrieved September 11, 2018, from https://dl.acm.org/citation.cfm?id=1661378](https://dl.acm.org/citation.cfm?id=1661378)

Three studies which examined the effects of learning through video games concluded that on average, students who played educational games scored higher on tests. In the studies examined, a group of business students were given access to a simulation business game, which allowed them to observe outcomes as factors were varied. Students who played the game felt more connected to their learning, as one participant commented; “in the game, it’s an experience that really stays with you, you actually learn...” demonstrating the depth of their engagement. These students averaged approximately ten percent higher on test scores than the traditional methods control group. About 227 students played the game while 801 students did not. Similar or even greater gains were seen in similar studies explored by the article. In these studies, video games were implemented for educational purposes to improve comprehension and retention of information. We built on this idea, combined with the elements of active learning previously mentioned, to create an immersive, kinesthetic learning experience which inspires students as well as bolstering academic success.

[Brolliar, C., Cox, P., Oswald, M., & Williamson, K. \(2018\). \*Mystery Room: Engaging Marginalized Youth through an Immersive Experience\*\(Rep.\). Worcester, MA: WPI.](#)

This past WPI IQP project had the same assignment as us last year. Though we were



given the same task, we have modified our project in order to build on their mystery room experience. We have developed an entirely new narrative, so that Banksia can choose from a wide range of mystery rooms in order to run them in the future with less repetition. Also, we chose to build on this team's concept of a mystery room experience by adding a pre-room, debrief, and post-room activity. Adding these rooms to the experienced helped to organize the children and more importantly foster learning by giving them the opportunity to play with science puzzles. Another difference is that we automated the room instead of using an actor as a means to decrease cost. We delivered a narrative through videos and audio clips and operated the lights and audio from behind the scenes to guide the participants through the mystery room. Though we built upon this team's mystery room experience, we used some of their information; particularly about our sponsor. The mission of the Banksia Gardens Community Service center is to improve the lives of its surrounding community. In Banksia Gardens Community Service center's words, their message is "Transforming Lives, Strengthening Communities, Reducing Disadvantage". They are committed to being leaders in education, training, and community engagement through opportunities for the disadvantaged. They are a semi-public organization funded through donations and government contributions. As of 2018 they have a budget of 1.2 million dollars which provides 5.7 million dollars worth of services per year. The Banksia Gardens Community Service center is managed by a board of governance and has over 40 employees. Often the Banksia Gardens Community Service center works with other organizations and volunteers in order to better provide helpful tutoring and learning experiences. The Banksia Gardens Community Services Center has one main building containing a childcare center, several classrooms for study groups and courses, an information technology room, a large hall, and a courtyard. In this building they run numerous programs for both adults and adolescents. These programs include: job-training, socialization, computer programming, homework help, and basic life skills. Each year around 80,000 people are helped by the programs. The Banksia Gardens Community Services Center offers additional programs targeted towards the local community. They offer direct hands on assistance through their homework club and

computer club. In the homework club volunteers help children that need academic support, while allowing the children to develop social and emotional skills through recreational activities. Often this club involves math tutoring, aid with reading, and support while creating STEM projects. This club is for any primary or secondary student on Tuesdays, Wednesdays, and Fridays starting at 3:45 pm and ending at 5:30 pm. In their computer club they enable the youth to have time on computers and learn programming skills through coding games and tutoring sessions. The computer lab provides free internet access to everyone, with learning resources such as STEM related games readily available. This opportunity allows the youth to learn important technological skills that they might not have any other access to. This information was imperative for our group because it allowed us to understand the community we worked with in order to understand how they think and learn.

[Cohen, S. S., Henin, S., & Parra, L. C. \(2017\). Engaging narratives evoke similar neural activity and lead to similar time perception. \*Scientific reports\*, 7\(1\), 4578. doi:10.1038/s41598-017-04402-4](#)

This research report states that humans lose track of time when they are engrossed in a story. It explains how engagement with a story causes distorted time perception and the neural responses associated with the perception of time. They used electroencephalographic responses of different viewers and correlated them to the viewers perception of time. They found that when the attention of the audience is captured, neural processing and subjective perception of time are affected.

[Daugherty, M. K. \(2013\). The Prospect of an "A" in STEM Education. \*Journal of STEM Education: Innovations and Research\*, 14\(2\). Retrieved from <http://jstem.org/index.php/JSTEM/article/view/1744>](#)

The author of this article said that students learning STEAM subjects use both sides of the brain together as art uses the right hemisphere and STEM based skills use the left side of the brain. This cohesiveness enhances learning and provides a better chance for students to come up with creative ideas to use in science and engineering. Researchers also found that visual learning helps to engage the brain. In an experimental study,

students who were able to think and communicate visually significantly improved how they performed in the study. Art allows students to come up with creative ideas through a different way of thinking and learning. With art, people with no interest in science and engineering are able to understand science concepts and apply them in innovative ways.

[Department of Education and Training Victoria. \(2017\). \*Education State Ambition: Learning for Life\*. Retrieved from https://www.education.vic.gov.au/Documents/about/educationstate/EducationState\\_LearningForLife.pdf](https://www.education.vic.gov.au/Documents/about/educationstate/EducationState_LearningForLife.pdf)

This document gives the educational objectives for the state of Victoria for math, science and reading for the next years. The government in the state of Victoria is hoping to increase the students in the top 2 proficiency levels of science from 10.0% in 2016 to 14.6% in 2025. This is one of their major STEM related educational goals. This was useful information as it gave us better insight into Victoria's educational system.

[Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Jordt, H., & Wenderoth, M. P. \(2014, June 10\). \*Active learning increases student performance in science, engineering, and mathematics\*. Retrieved September 11, 2018, from http://www.pnas.org/content/111/23/8410](http://www.pnas.org/content/111/23/8410)

This analysis of studies compared student performance in traditional learning vs active learning environments. The overall outcome of the studies showed a strong positive correlation between active learning strategies and test scores. For students who participated in active learning strategies, performance on exams increased by about half a standard deviation, and student failure rates decreased. This demonstrates that the way students learn has a significant impact on achievement, and that active learning leads to positive academic outcomes.

[Guo, J., Parker, P. D., Marsh, H. W., & Morin, A. J. \(2015\). \*Supplemental Material for Achievement, Motivation, and Educational Choices: A Longitudinal Study of Expectancy and Value Using a Multiplicative Perspective\*. \*Developmental Psychology\*. doi:10.1037/a0039440.supp](https://doi.org/10.1037/a0039440.supp)

This study explored motivational influences in the selection of a STEM career pathway. It highlighted the role of value (whether or not they view it as important) in a student's choice of career. It notes that in some cases, the value a student perceives a subject to have can be more predictive of career path than subject interest. If students believe a subject is valuable, they will be more likely to pursue higher level courses on that subject.

[Ho, A. M. \(2018\). Unlocking ideas: Using escape room puzzles in a cryptography classroom. PRIMUS, \(just-accepted\).](#)

This peer reviewed journal article talks about how escape rooms are growing in popularity because of their educational value. By using highly engaging puzzles, educators can implement escape rooms into their classrooms. This article suggests that group work can promote a deeper understanding of content and skill outside of the classroom. From this article and our other research, we believe a mystery room is an excellent way to combine both of these ideas into an interactive learning experience.

[Hume City SEIFA Report\[PDF\]. \(2018, June 30\). Hume City: Hume City Council.](#)

The Hume City SEIFA Report provides social, economic, and other population statistics within the Victoria area. This report helps us by showing that Broadmeadows is an educationally and economically disadvantaged community. This source provided us with relevant demographics and statistics about the Broadmeadows community.

[Konopka, C. L., Adaime, M. B., Mosele, P. H., & Scientific Research Publishing Inc. \(2015, August 12\). Active Teaching and Learning Methodologies: Some Considerations. Retrieved September 11, 2018, from \[http://file.scirp.org/Html/7-6302666\\\_58748.htm\]\(http://file.scirp.org/Html/7-6302666\_58748.htm\)](#)

In this journal article, Konopka defines active learning as “the process of acquiring knowledge, skills, values and attitudes by any educational strategy that involves or engages students in the process by leading them to activities and debates.” In other words, in active learning, a student's primary source of information may include games, activities, or other strategies that facilitate learning through collaboration, as opposed to students passively receiving information. Active learning is an essential step to getting the student's attention and keeping them engaged.

[Lew-Williams, C., & Princeton University. \(2016, October 3\). Forget flashcards, play with](#)

sticks.

[An expert explains how children learn. Retrieved September 11, 2018, from https://www.weforum.org/agenda/2016/10/forget-flashcards-play-with-sticks-an-expert-explains-how-children-learn/](https://www.weforum.org/agenda/2016/10/forget-flashcards-play-with-sticks-an-expert-explains-how-children-learn/)

In this online article, researcher Casey Lew-Williams studies how children learn, and the key elements in their development. He describes here how poverty affects learning through in-home use of language. Students growing up in poverty hear as little as one-third of the words wealthy children do, which feature into their cognitive development later. Play is also emphasized as a cognitive process; regardless of whether or not children have plastic toys or just sticks, the cognitive processes required for imaginary play helps children develop complex development skills. This article highlights the benefits of active social interaction and active learning outside the classroom.

[Mastascusa, E. J., Snyder, W. J., & Hoyt, B. S. \(2011\). \*Effective instruction for STEM disciplines: From learning theory to college teaching\*. San Francisco, CA: Jossey-Bass.](#)

This book tells us that lack of engagement in STEM is a significant problem among students. It explains that a lack of engagement in school affects retention, performance, and motivation. The source also explains that the engagement problem extends especially to the STEM field. This explains the causes of the problem we have been asked to solve. The source also gives information on how to teach more effectively than the methods used in a traditional classroom setting, so we will use these strategies to engage the Banksia youth in STEM.

[Marrero, M. E., Gunning, A. M., & Germain-Williams, T. \(2014\). \*What is STEM Education?\*. \*Global Education Review\*, 1\(4\).](#)

This journal article states that STEM is an acronym used in the context of both school and industry. When used in school context, it refers to the learning of these four major topics. When used in an industry context, it refers to the careers that focus on the four areas.

[Mills, M. & McGregor, G. \(2016\). \*Engaging students in engaging schools: Lessons from\*](#)

[Queensland's alternative education sector. Brisbane: YANQ. ISBN: 978-1-74272-164-4](#)

In the background section of this report on engagement, the University of Queensland and other affiliated associations explore the relationship of poverty and low socioeconomic status to academic performance. The report explains that while academic performance is decreasing country-wide in recent years, it is decreasing by significantly more in lower-income neighborhoods compared to high-income neighborhoods. The number of students who do not graduate in year 12 also jumps from 26 percent to 40 percent in these areas.

[Nicholson, S. \(2018\). Creating Engaging Escape Rooms for the Classroom. \*Childhood Education\*, 94\(1\), 44-49. doi:10.1080/00094056.2018.1420363](#)

This journal article gives a good definition for an escape room: “live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time.” The article distinguishes live-action games from regular games. Live action games allow participants to engage directly with the game world instead of operating through a screen. This article discusses how escape games are beneficial in a classroom, gives examples of escape games. Escape Rooms are only one type of escape game, which includes a time limit and a series of puzzles. The article also gives tips on how to tell a good story. Tips include getting the players directly involved and making their decisions actually matter. A very valuable portion of this article discusses how to avoid making the mystery room superficial. The author warns against focusing on locks and boxes, because the students will not learn as much. Replacing a teacher’s grading pen with a key to a box will get redundant and is not an effective way to be engaging . Rather, keys and locks should be part of the narrative, not just a means to check students’ work. The students should leave the activity with a curiosity of how the topic relates to their life and be curious to learn more, rather than being motivated by grades. We can use this article’s tips for engagement and avoiding a superficial game room. When developing our room we will continue to refer back to these suggestions to make sure the players are

directly involved in the outcome of the room and that the story is engaging for the students.

[Pfeiffer, L. \(2017\). Explainer: STEM, and what it means to Australia's Education System. \*The Sydney Morning Herald\*. Retrieved from https://www.smh.com.au/education/explainer-stem-and-what-it-means-to-australias-education-system-20170105-gtm93f.html](https://www.smh.com.au/education/explainer-stem-and-what-it-means-to-australias-education-system-20170105-gtm93f.html)

In this online article, Dr. Linda Pfeiffer says that STEM is a way of thinking and not about science, technology, engineering and mathematics as individual subjects but as a whole. STEM requires students to identify a problem and create possible solutions that could be tested to solve the problem. It requires a student to think through a problem and engage with it. She goes on to talk about common misperceptions of STEM as being just technology and engineering, but STEM is the entire world around us. STEM is important because new, creative ideas are continually needed to solve the world's everchanging problems. In 2015 the Australian government announced an agenda with the goal encourage "all Australians-from preschoolers to the broader community- to engage with STEM." Within the last few years the government has put money into STEM to fund new curriculums, train teachers, and on professional learning programs. The goal of the Australian government is for STEM to be delivered in a way that encourages thinking, curiosity and use of the scientific method.

[Pressick-Kilborn, K. \(2018\). The 'right' age to start school varies for each child. \*The Conversation\*. Retrieved from https://theconversation.com/the-right-age-to-start-school-varies-for-each-child-98704](https://theconversation.com/the-right-age-to-start-school-varies-for-each-child-98704)

This online article was used to determine what year in school our target age group is in. This was important for us to use so we could look at the educational frameworks for our specific age range of students.

[Prithwi Raj Subramaniam \(2010\) Unlocking the Power of Situational Interest in Physical Education, \*Journal of Physical Education, Recreation & Dance\*, 81:7, 38-49, DOI: 10.1080/07303084.2010.10598507](https://doi.org/10.1080/07303084.2010.10598507)

Prithwi's journal article, while directed towards physical education, describes the general importance of student interest in education. Student interest level has a significant effect on learning, and if not present, significantly contributes to disengagement. He categorizes interest into situational and individual. Individual interest is a student's intrinsic inclinations towards certain subjects, whereas situational is the interests a student has due to the environment. While teachers have little capacity to change individual interest directly, they have full control over the learning environment, and the situational interest they generate can translate into long-term effects.

[Remeikis, A. \(2018, April 02\). Educational inequality widening Australia's rich-poor gap, report finds. Retrieved September 21, 2018, from https://www.theguardian.com/australia-news/2018/apr/03/educational-inequality-widening-australia-rich-poor-gap-report-finds](https://www.theguardian.com/australia-news/2018/apr/03/educational-inequality-widening-australia-rich-poor-gap-report-finds)

This online article discusses how the educational inequality is widening the gap between the rich and poor in Australia. Recent Australian studies cite a pronounced achievement gap between low-income and high-income students. The income gap is defined as the comparison between families in the 90th percentile and the 10th percentile of family income distribution. In Australia, where our study is to be set, not only is academic performance country-wide decreasing, but it is decreasing by 50% more in the bottom portion of the socio-economic spectrum than it is in the top.

[Stone, Z. \(2016, July 28\). Why Teachers Are Asking Students to Escape From the Classroom. Retrieved from https://www.theatlantic.com/education/archive/2016/07/the-rise-of-educational-escape-rooms/493316/](https://www.theatlantic.com/education/archive/2016/07/the-rise-of-educational-escape-rooms/493316/)

This online article gave information on why escape rooms are helping students, and what makes a game engaging. It says escape rooms help students learn because applying knowledge improves retention. This website provides specific examples of escape rooms. It explains a scenario where a robot was programmed to destroy a hospital and the kids must find keys by decoding passwords and using black lights to find hidden clues. We may be able to use some of the specific ideas presented in this article. We were able to



use the information about why escape rooms are particularly effective. For example, the author says escape rooms are effective because they put the player directly into the game, and this takes away the barrier that most games have.

[Subban, P. \(2016, February 5\). Australian students are becoming increasingly disengaged at school – here's why. The Conversation. Retrieved October 8, 2018, from](https://phys.org/news/2016-02-australian-students-increasingly-disengaged-school.html)

<https://phys.org/news/2016-02-australian-students-increasingly-disengaged-school.html>

This online article talks about why students are becoming disengaged in education in Australia. In the classroom, students do not feel engaged, which leads them to be disconnected from what they are learning. In fact around one in five Australian students do not find school engaging. This lack of engagement makes them less likely to succeed in and continue with school. It was found that about 25% of disengaged young people did not end up completing school. The article then goes into talking about how to make schools more engaging. It suggests using a personalized approach when it comes to learning. This allows the students to be taught material that is at their level so that school is not too hard or easy for them.

[Tavernise, S. \(2012, February 10\). Education Gap Grows Between Rich and Poor, Studies Say. Retrieved September 21, from](https://www.nytimes.com/2012/02/10/education/education-gap-grows-between-rich-and-poor-studies-show.html)

<https://www.nytimes.com/2012/02/10/education/education-gap-grows-between-rich-and-poor-studies-show.html>

This is a New York Times article discussing the increasing education gap between the rich and the poor in America. Researchers from Stanford University and the University of Michigan have hypothesized that the correlation between economic status and achievement might be due to affluent families spending more of their income on their children's education and extracurriculars. The article also goes on to explain why the education gap travels across generations, with the main reason being that educated people are more likely to marry other educated people.

[University of Minnesota \(2018\). Active Learning. Retrieved November 8, 2018 from](https://cei.umn.edu/active-learning)

<https://cei.umn.edu/active-learning>






This source gives a direct comparison between active learning and “traditional” learning.

Traditional learning is described as “a method of instruction in which students are passive recipients of knowledge from an expert. Active learning is a scenario in which students engage in the learning process, and can include writing, talking, problem solving, and reflecting. This source gives us a definition of a traditional classroom and allows us to show that our mystery room is inherently different from traditional learning.

## Appendices

### Appendix A: Survey for Students

Do you **like**:






	 Strongly Dislike	 Dislike	 In the Middle	 Like	 Strongly Like	? I don't know
Biology						
Chemistry						
Physics						
Computers						
Mathematics						
Electrical Engineering (wiring things)						
Mechanical Engineering (building things)						
Chemical Engineering (mixing things)						
History						
English						
Physical Education						
Art						
Music						

## School

What are your favorite subjects in school? \_\_\_\_\_

What else would you like to learn in school? \_\_\_\_\_

Do you think it's **important** to learn:

	 Very unimportant	 Unimportant	 In the Middle	 Important	 Very Important	? I don't know
Biology						
Chemistry						
Physics						
Computers						
Mathematics						
Electrical Engineering (wiring things)						
Mechanical Engineering (building things)						
Chemical Engineering (mixing things)						
History						
English						
Physical Education						
Art						

Music						
-------	--	--	--	--	--	--

## Outside of School

What activities do you enjoy the most? \_\_\_\_\_

\_\_\_\_\_

What other activities would you like to do? \_\_\_\_\_

\_\_\_\_\_

## Appendix B: Focus Group Questions

1. Can you tell us what you remember about the mystery room, from start to finish?
2. Did you feel like you were a part of the story?
  - a. Did you like the story?
  - b. How did you feel about it? Was it funny? Scary? Cool? Boring? Exciting?
3. What did it look like in the room?
4. What was your favorite part?
5. What was your least favorite part?
6. Which puzzle was your favorite (why)?
7. Which puzzle was the easiest?
8. Which puzzle was the most difficult?
9. Did you notice the voice that was giving you hints during the room?
  - a. Did it help you?
10. Did you notice the lights changing at each challenge?
  - a. Did they help you?
11. Did you learn anything during the mystery room experience?
  - a. What school subjects did the mystery room teach you about?
12. Could you recognize what the science was behind each puzzle?
  - a. Of all the things on (survey), which ones do you think were involved in the room?
13. Did the activity change the way you think about certain school subjects?
14. Did playing with the activities afterward help your understanding of the concepts?
15. Is there anything you think should be changed about the whole experience?

## Appendix C: Handbook

# Operations Handbook



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*Banksia Gardens*  
Community Services



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## Unpacking

To unpack the mystery room, you will need to compile all of the room elements. The first major elements to the room are the backdrops. These 4 backdrops are large silver pieces of cardboard lined with thin wooden framing, and labeled with where they must be placed in the mystery room. There are also two table tops and two tunnel flaps, all made of cardboard, which help to create the environment of the spaceship. Other materials you will need are the wooden challenge pieces for the electrical and mechanical challenges. The electrical challenge has an LED and three fans attached to it, and the mechanical is silver with 7 holes along its length.

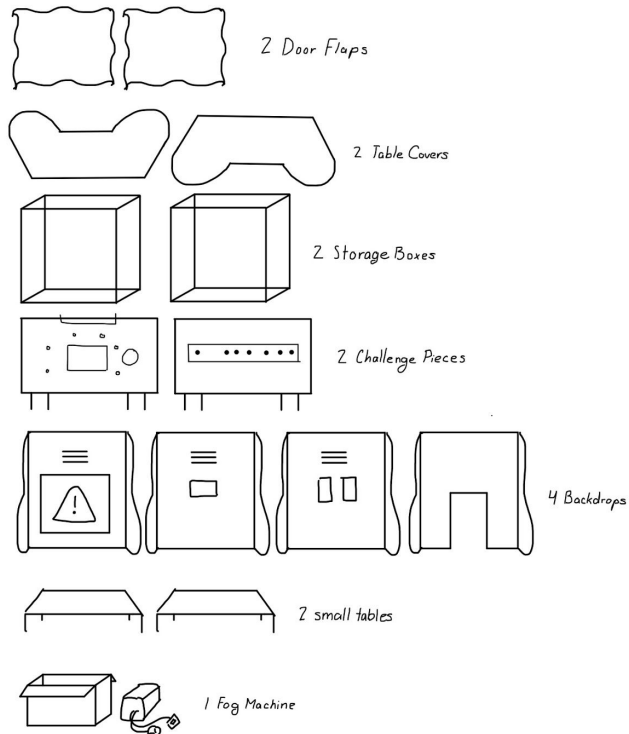
Many of the smaller elements of the room are packed into two boxes, labeled and stored in the closet in the back office. We ask that you handle the Erlenmeyer flasks and Adafruit LEDs with care, as they are breakable/fragile. Descriptions of specific use can be found in the remainder of this document.

In addition to the two boxes and backdrops, you will need two tablecloths, two small tables (which we found in the childcare room), a fog machine and respective parts, and potentially an extension cord and power strip for powering parts of the room.

## Catalogue

- Pre-Room
  - 4 Video files
  - Projector/Large screen with speaker
  - 4 Role Cards
  - 2 Puzzle pieces
  - 2 Torches (Normal and UV)
- Ambiance
  - 4 Cardboard Backdrops
  - 2 Table Toppers
  - 2 Cardboard Tunnels
  - 2 Tunnel Flaps
  - 2 Speakers (likely not stored with the Mystery Room)
  - 4 Rolls of Generic Remote-Controlled LED's

## INVENTORY



- 4 Power Cords
  - 4 Converter/IR Receiver boxes
  - 4 Remote Controls
- Programmable Adafruit Analog RGBW LED Strips (3) with control board
- Mechanical Engineering Puzzle
  - Wooden Challenge Piece
  - 3 Wooden Gears
  - Puzzle Hint Paper
- Electrical Engineering Puzzle
  - Wooden Challenge Piece
  - Alligator Clip Cables
  - 2 6V Batteries
  - Wires to Connect 2 6V Batteries in Series to Electrical Challenge
- Chemical Engineering Puzzle
  - 4 Erlenmeyer Flasks
  - 2 Mason Jars
  - 6-Piece Instruction Puzzle
  - Alka-Seltzer Tablets
  - 2 Spill Trays
  - 1 Measuring Cup
  - Food Coloring
  - 2 Stirring Sticks (Chopsticks)
  - 2 Water containers
- Other
  - 5 Digit Combination Lock (not used)
- Post-Room
  - Laminated Storyboard
    - Full
    - Cut
  - Section Labels
  - Post-It-Notes
  - LED Instructional Drawing
  - 4 Written Instruction Sets
  - Broken Toy Car with Wiring
  - Electrical Experiment Board
  - 2 Mason Jars
- Focus Group
  - Post survey
  - Photos of Challenges
  - Emoticon/Number Cards
- Digital Resources:
  - Audio Clips, Videos, and Ambiance
    - [“Mystery Room Files”](#)
- Purchase/Obtain
  - Vegetable Oil
  - Water
  - Dish soap

## The Room Setup

Note: Setup is about 1.5 hours for 2 people who had no previous experience setting up the mystery room. For a team of 3 with experience setting up the room, setup is about 45 minutes.

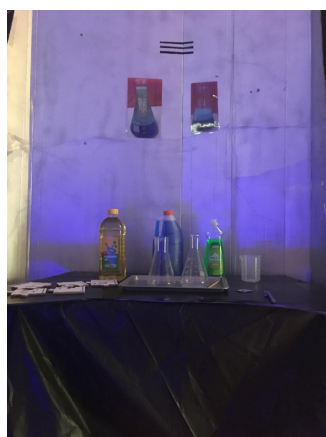
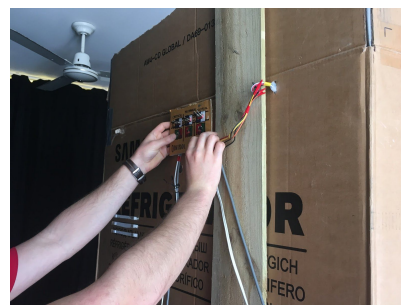
Setting up the room consists of several parts. Please read through all of each paragraph before acting on the instructions in the paragraph.

The environment of the room is enhanced by the use of the blackout curtains in Banksia’s childcare room. To begin establishing the ambiance, draw the blackout curtains fully, leaving a space only for the entrance door. The only items remaining in the space created by the curtains

should be two small tables for the chemical and mechanical challenges. Once the space has been created, the backdrops should be set up in their respective spaces in the room. The entrance backdrop goes over the door, the chemical backdrop goes closest to the door along the short wall, the mechanical backdrop goes against the long wall across from the door, and the electrical backdrop goes along the short wall farthest from the door (photo below). Both the chemical and mechanical backdrops have wooden kickstands in order to stand up. The electrical backdrop does not have a kickstand and in order to stand properly it will need the wood challenge piece. The wood challenge piece sits behind the backdrop and its components should match up with the holes in the cardboard. We would recommend securing these to each other using duct tape, this should be done after putting the battery in as described below. Make sure the lights for the room are turned off before you place the entrance backdrop, as once this is up you will not be able to access the light switch. The entrance backdrop will also need to be taped in place on both sides (to the shelves and to the pole next to the door). An extension cord will need to go behind the entrance backdrop as described in the next paragraph so it might be easiest to tape the backdrop up once the cord has been wrapped around. Each table needs a tablecloth and a table cover. The plastic tablecloth should be placed on the chemical table, with the chemical table cover on top. The two table covers are the black pieces of cardboard that go on top of the table. The back of each table cover is labeled with the name of the challenge it belongs to. They should be laid on the table, black painted side up with the straight edge along the back of the table and the rounded parts coming out towards the middle of the room. The mechanical challenge will also need a tablecloth with the mechanical table cover on top. Make sure there is enough room behind the mechanical backdrop for one of the operators to stand between the backdrop and the curtain. The backdrops for each challenge will need to be placed close together, to ensure that the Adafruit LEDs (which go through the top of the backdrops) reach all the way, so the backdrops may need to be adjusted later.



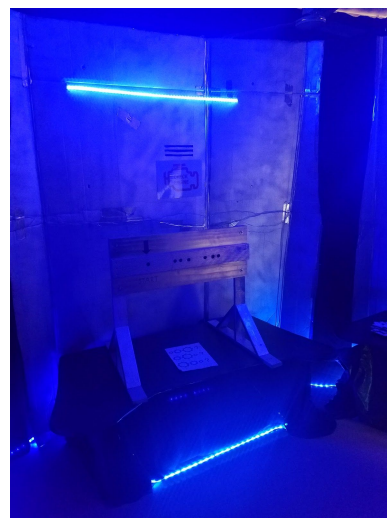
Through each of these cardboard backdrops should go LED Strips, the lights should come from behind the backdrop to the front, through the cutouts on the bottom of the backdrop (see photo). Using 2 rolls of the remote-control LEDs, string lights around the bottom of the challenges. One strip can go through the bottom of the electrical and then mechanical backdrops (this strip will just barely make it to end of the mechanical backdrop and may need to be taped to the back of the backdrop to make sure the strip stays in place), and another should come from the other direction (over the tunnel entrance in the doorway) to go through the chemical. If you string them through all on one strand, the power will not reach the farthest end of the last LED strip. The extension cord will be needed for the LED strip that goes over the doorway and through the chemical challenge backdrop, the extension cord should go behind the door backdrop, secured with tape and then come out from under the curtain to go to the chemical backdrop. The extra LED's from this strip can then be strung through the mechanical backdrop on the side closest to the chemical challenge and wrapped around the table on the floor, secured down with tape. The pronged end of the LED is what connects to the white block (the part that plugs into the black wall plug). You should start with plugging the lights into the outlet first and then stringing them through the cardboard to ensure that the lights are spaced out in a way that it reaches the outlet. Another thing to note is that the white blocks need to be placed in a spot where the operator can see the IR Receiver so the lights can be changed colors with the remote. The Adafruit LEDs and control board will be strung through the holes along the top of the challenges. The control board can be mounted with tape to the center of back side of the mechanical backdrop (at about eye level), and each LED strip (as labeled) will extend to the other challenges from there. The power for these strips is run off of the 12V power supply which will be mounted behind the electrical challenge, so the free ends of the wires should be left there for later setup. Once all LEDs are in place, we suggest taping as needed to make the strips look straight and even. Make sure you test the lights once you finish wiring them to ensure that everything works before you move on.



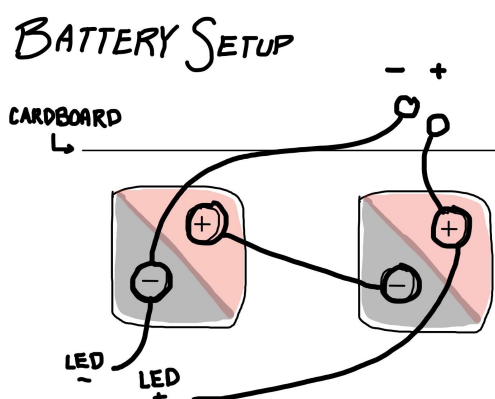
The chemical challenge requires one tray, two Erlenmeyer flasks, a container of water, a container of oil, a small measuring cup, a stirring stick, dish soap, and an alka-seltzer packet to be placed on the table. The other tray and flasks, as well as extra tablets, water, etc. will remain behind the curtain, outside of the scope of the room, for quick resets between rooms. For added effect, dye the water a color of your choice (blue worked well) using the food dye included. 4 of the pieces

from the 6 piece puzzle will start on this table as well (the others will be brought in by participants). There are two pictures on the backdrop that show what the flasks will look like when the challenge is completed.

For the mechanical challenge, a table should be placed in front of the challenge's cardboard backdrop. The wooden challenge piece should be placed on top of the table (with the table cover), with all of the gears set under the table, and hidden by a tablecloth. Make sure the wooden challenge piece is facing the correct direction with the side that says START facing towards where the students will be. The hint paper should remain on top of the table.



For the electrical challenge, ensure that the wires from the backboard that have a ring-shaped end are pulled through the cardboard in their proper positions, as labeled. There are two small holes in the cardboard for each component in the challenge; the fan, battery, and light. Each component has one hole labeled with a positive sign, and one hole labelled with a negative sign. The wires on each component are labeled as positive (red) or negative (black), so each must be pushed through the respective holes in the cardboard. The positive and negatives are labeled on both sides of the backdrop to help with setup. The two 6V batteries should be connected in series. The positive terminal of one battery should be connected to the negative of the second, with the negative ring wire attached to the negative terminal of the first battery, and the positive ring wire attached to the positive terminal of the second battery. These two rings should be pulled through in the battery spot. In the same place as the ring wires are connected, the Adafruit (top) LED power wires should also be connected. The positive (red) wire should go to the positive, and the negative (black) to negative. On the front of the board, the two clips should start attached to the red LED light, so it starts on. This means clipping the positive terminal of the battery to the positive terminal of the LED, and the negative to the negative. Please ensure the alligator clips are not touching each other- this will create a short. If the LED is not turning on, and/or the battery is getting hot, you likely have a short and may need new batteries. Make sure you test that the LED's are functional before moving on to the next part. To finish the setup for this section, place and close the locks on either corner of the emergency panel. Once the battery is in, and the lights are tested for



functionality wooden challenge piece should be secured with tape as described earlier in the paragraph that describes setting up the backdrops.

Once all the backdrops and lights are set up, there is a black curtain that needs to be wrapped around all the backdrops to make sure the participants in the room cannot get behind the backdrops and see the operators. This can be done by starting at electrical backdrop and taping the curtain to the black ambiance curtains (curtain on the track attached to ceiling) and wrapping it around the electrical backdrop, the mechanical backdrop and the chemical backdrop. You will need to tape it at a few points along the back of the backdrops. But make sure that the curtain does not cover the cutouts that the operators use to see what is happening in the room.

The remaining elements of the room are less tangible. To play the music and audio clips, you will need to set up and connect to two speakers which you should hide within the room. Each speaker connects differently, but generally, to do this, open bluetooth pairing on your device, and press the pairing button on the speaker. We did the backtrack of the room from a phone, and the audio clips from a laptop. The digital files from [“Mystery Room Files”](#) should be downloaded onto a flash drive and copied to the appropriate computers.

Finally, the fog machine should be plugged in (may require extension cord) behind the electrical challenge. There is a small hole for the fog to go through in the board; please set the fog machine back a few inches, so that participants do not try to touch it, as the machine can get very hot. For an image of how the final room should look, see figure x. Since the fog machine could set off the fire alarm, the smoke detector will need to be covered with a plastic bag and secured with string wrapped around it.



Final set-up for Electrical (left), Mechanical (middle), and Chemical (right) challenges.

## Pre-Room and Debrief

Setting up the Pre-Room is a job that can be managed by one person. 15 minutes should be enough to test that all parts are running correctly. All required materials are in a blue bag labeled pre-room.

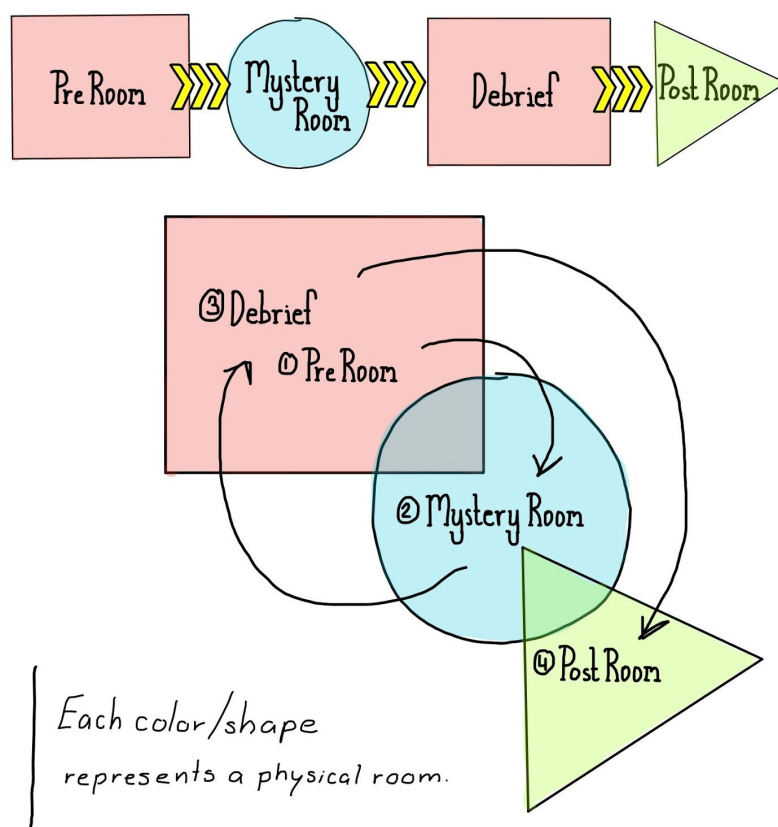
The environment of the room should be a large screen with four (non-swivel) chairs placed in front of it. We used the computer room for this. The 4 videos “[Mystery Room Files](#)” should be loaded onto a computer (connected to the projector) with a speaker hooked up to it. The room should have no unnecessary distractions including the computer used set to only display on the projector. The 4 role cards should be laid out and paired with their prop (out of reach of the students). Badges should be kept out of sight but easy to access.

## The Room

### Running the room (3 people + 1 guide)

*To be read before running the room*

The mystery room experience is divided into four components: the Pre-Room, the Mystery Room, the Debrief, and the Post Room. The Pre-Room consists of video instructions and narrative development to introduce the participants to the objectives of the room. In this room should be one staff member, the [Pre-Room Operator](#). The Mystery Room acts as the “spaceship” in which the kids will enter in order to solve all of the puzzles. In this room there should be three staff members: the [LED Operator](#), the [Audio Operator](#), and the [Technical Assistant](#). After completing the mystery room, students should return to the same physical room as the pre-room to [debrief](#). The same staff member who operated the pre-room can operate this activity as well. To conclude the activity, one staff member should operate the [post-room](#), a space where students can use their badges as an entrance pass to play with the challenges at their own pace. Aside from this, two staff members will need to function as [Guides](#), who will help ensure the right students enter the room at the right time, and accompany them through the room to supervise completion of activities. A visual overview of the order of these rooms can be seen in figure x below.



## Success Conditions

In the chemical engineering challenge, successful completion of the challenge involves two full beakers filled with the components outlined in the instructions. The first beaker should consist of oil, water, and one Alka-Seltzer tablet. The second beaker should consist of oil, water, and a few squirts of dish soap. Once the second beaker is stirred and all other instructions are followed correctly, the challenge is completed successfully.

In the mechanical engineering challenge, successful completion of the challenge includes a placement of all three gears into the holes on the board in size order from biggest to smallest. Once the participants place the gears in the correct order and manually spin the leftmost gear, the challenge is considered completed.

In the electrical engineering challenge, successful completion of the challenge includes a completion of a circuit between the battery and the fan. A completed circuit includes the connection of the positive terminals of the battery and the fan with one wire, and the connection of the negative terminals of the battery and the fan with the other wire. This condition is easily recognizable because the fans will turn on and the streamers will be blown into the air. Once the fans are activated, the challenge is successfully completed.

## Operations

*To keep with you while running the room*

### LED Lights

#### General Information

The controls for the programmable LED lights at every challenge are located on a cardboard control panel. Once all of the LED's are wired, the control panel is most effectively placed behind the cardboard backdrop for the mechanical engineering challenge, where the wires can reach each of the challenges. The control board consists of a set of controls for each of the three challenges. Each challenge has two metal switches. The switches turn the LED lights at the respective challenge either blue or white until the switch is turned off. Each challenge also has two buttons. The buttons turn the LED lights either red or green, but only for the duration at which the button is pressed. Please note that only one color should be activated at a time, because colors mix when multiple are activated simultaneously.

Ultimately, the process of operating the lights is the same for each puzzle. The lights at the desired challenge should first be turned white to direct the team to complete the puzzle. When the challenge is done incorrectly, the operator must flash the red lights 2-3 times. When

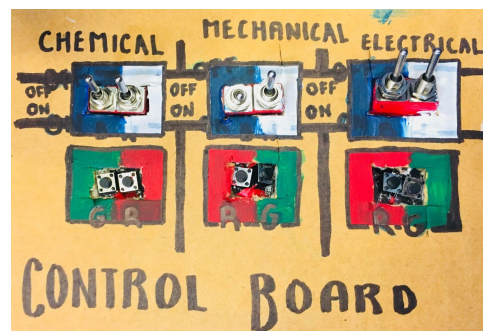


the challenge is done correctly, the operator must flash the green lights 2-3 times. After flashing the green lights, the lights at the station must be turned blue to indicate that the challenge has been completed. This process is repeated at each station. Please note that only one color should be activated at a time, or else colors will blend and be distorted. After each time the room is run, all LED's should be turned off and the process is repeated again for the next run of the room.

### Step-By-Step Operation

When the participants enter the mystery room, all programmable LED's should be turned off until the last person enters the room. At this point, the white light for the chemical engineering challenge should be activated in order to direct the team to the first challenge. Once the challenge is completed successfully, the operator must turn the white light off and flash the green light to indicate success of the challenge. Note that the red lights are not used at this station because instructions are clearly outlined, and amounts of each liquid are not critical. Once both beakers are filled as according to the instructions, the challenge is completed. After flashing the green light, the lights at the chemical engineering station should be switched to blue for the remainder of the room to indicate that the challenge has already been completed.

Once the lights at the chemical station have been turned blue, the lights at the mechanical engineering challenge should be switched to white in order to direct the team to their second challenge. If three gears are placed onto the board in the incorrect order, the operator must flash the red light to indicate that the team must try a different order for the gears. This process is repeated each time the team places the gears in the incorrect order. Once the team puts the gears in the correct order, from biggest to smallest, and spins the leftmost gear, the challenge is completed. Once the challenge is completed the operator must flash the lights green to indicate challenge success. Then, the lights at the mechanical engineering station must be turned blue to indicate that the challenge has been completed.



Once the lights at the mechanical station have been turned blue, the lights at the electrical engineering challenge should be switched to white in order to direct the team to their third and final challenge. Once the participants wire the battery to the fan successfully, the fans will turn on. When the fans turn on, the operator must flash the lights at the electrical station green to indicate challenge success. Note that the red light is not necessary at this station, because participants will understand that they have not wired the fan correctly if it does not turn on. After flashing the lights green, the lights at the electrical station must be switched to blue to show that the challenge is completed.

## Audio Technician

The audio operator's job is to play the correct audio clip at the correct time to guide the students around the room. This job is complicated by the fact that the audio operator cannot see what is happening in the room at any time, and so must be guided by the technical assistant and LED operator. We recommend you create a series of hand signals based around what is happening in the room, on which we will elaborate shortly.

The Audio Technician's physical position is sitting on the floor behind the electrical challenge, to the right of the technical assistant. You must be in such a position that, with the LED remote control, you can change the color of the Electrical and Mechanical Areas' floor-level LEDs. Near you should also be the button for the fog machine.

The file system for the hints is labeled in order by challenge, with 1 being the chemical challenge, 2 being the chemical, 3 being the mechanical, and 4 being the ending sequence. At the beginning of each new challenge, play the first (X.1) file, called descriptions or instruction. Any other hint from there is based on the students' behaviors. In some sections, there is more than one clip of general instructions or more than one introductory cinematic that must be timed with student behavior:

- Chemical:** Play "1.1 Description" As soon as the last student has entered the room.
- Mechanical:** Play "2.1a Under the Table" As soon as the LED operator flashes the green light for mechanical.  
Play "2.1b Instructions" once the students have retrieved the gears from under the table, and have had a second to look at them.
- Electrical:** Once LED operator flashes the green light for electrical:  
Switch LEDs to red by pressing CS twice, then hitting "flash".  
Play "3.1a Description"  
Once students unlock the challenge, Play "3.3 Turn on Fan Instructions".
- Final:** Play "4.1 Leave Immediately" As soon as the LED operator flashes the green light for mechanical.  
Play "4.2 Countdown" A few seconds later.  
Switch LEDs to white by pressing the black ww button, then hitting "jump"

These clips and actions must be completed to shape the plotline of the room and provide guidance to students. Any other hints should be administered based on the needs of the students in the room. If the students are struggling to put the gears in order, perhaps play hint 2.6 "Big Gear First" to get them on the right track. Some hints, such as this, provide a step towards the

correct answer, where as other hints, such as 2.5 “Gears Must Touch” are to provide method-based corrections. Try to allow the participants a few tries before giving them hints towards the correct answer, but if they do not understand how the challenge works in general, always give method-based corrections as soon as possible.

Listening to the students’ verbal feedback will give you some indication of what they need to complete the challenge, but aside from this, you will need to take your cues from the technical assistant or the LED operator.

## Technical Assistant

In this position, you are responsible for communicating what’s happening in the room to the audio operator and the LED operator, as well as assisting with ambiance.

The technical assistant’s physical position is to the left of the audio operator, centered behind the electrical challenge so that you can see through the slits in the cardboard. You should be in such a position as to hit the button on the remote for the fog machine button with your foot (or hand, if you’d like to hold it).

The technical assistant’s job is to observe what is happening in the room and convey what the students need, through hand signals, to the audio operator and LED operator. Your focus should be primarily on the audio operator, as they will not be able to see the room at all. Once the students reach the mechanical challenge, you will need to convey their success or failure to the LED operator, as they will not be able to see that challenge. You can work out whatever system you would like with the other two room operators. We used a system like this:

**Completion of Puzzle** was marked with a thumbs up or a thumbs down, respective to whether it was a correct or incorrect answer.

**Repeating** any prompt was a loop with a single finger, used when students did not hear or were not listening to the previously given hint.

**Answer Hints** (have made multiple incorrect tries at correct answer) were signaled using a number of fingers. For example, the mechanical section has two Answer Hints: 2.6 “Big Gear First” and 2.7 “Biggest to Smallest”. These would be numbered 1 and 2, respectively.

**Method Hints** (wrong way to solve puzzle, eg. teeth on gears aren't touching) were signaled using a complex/specific gesture. For example, a pushing motion would indicate the audio operator should play clip 2.4 “Push All the Way In” for the mechanical section, or a plus sign with the fingers might represent clip 3.6 “Positive to Positive”.

Aside from this, the only other responsibilities the technical assistant has are to play the ambiance and trigger the fog machine. “Blazing Stars” should play in the background until the

electrical challenge begins, at which point the “alarm” sound should be played and repeated, and the fog machine should be used.

## Pre and debriefing

### Before starting

1. Test videos with audio and adjust volume (files [“Mystery Room Files”](#) )
2. Lay out the 4 role cards with their respective props (image below, materials in blue bag)
3. Have a timer ready (phone timer works)
4. Have badges out of sight
5. Make sure 4 non-swivel chairs are in front of the screen



### Running the pre-room and debrief (1 person)

1. Set up 1.1Video and 1.2Video (go to open multiple files on VLC media player)
2. Team of 4 students sent into pre-room (computer room) by a guide and instructed to take a seat
3. Play 1.1Video and 1.2Video (preloaded into VLC media player)
4. Hand each member of the team a role card and have them go down the line reading their cards out loud (if they cannot read their own card read it for them)
5. Hand each team member their respective prop
6. Send the team into the spaceship (childcare room) and **immediately start a timer**
7. Set up 2.1Video and 2.2Video (go to open multiple files on VLC media player)

*Team has fixed the spaceship and exited the spaceship*

8. **Stop the timer and record the time down (without letting the students see)**

9. Guide the students back into the pre-room and have them take a seat
10. Collect the role cards and props
11. Play 2.1Video and 2.2Video (preloaded into VLC media player)
12. Hand out one badge to each student and tell them it is their pass into the post-room (CEO office)
13. Guide them into the post-room (CEO office)

## Post

The person running the post room is in charge of making sure the post room runs smoothly and to help the students play with the challenges in the room. Not every kid will be interested in actually learning the concepts, but playing with them is enough to gain the interests of a lot of the students.

It is also important to make sure that there are not too many spills from the chemistry station, as oil is not very easy to clean up. Spills can also be a problem if they end up spreading to the other stations as the electrical kit, the story board and even the wood of the mechanical station should not get wet.

This job also requires answering some questions. Not all of the students are interested in asking questions, but some kids will be. This is what the write ups on the table are for, to help the person running this room answer questions if they aren't sure what the answer to the questions are. The write ups are a brief description of the puzzle and the concept the students learn from it.

## Guides (2)

Each team should have an adult guide that is supervising the team. The guide that is on the spaceship should be listening closely and vetoing any idea that could be a safety issue or damage any mystery room equipment.

The guide that is not in the room is responsible for managing students outside of any of the rooms and making sure the next group is ready to begin. Additionally the guide outside is responsible for shutting and opening the door to the spaceship (childcare room), this process involves moving the tunnel and turning on and off the tunnel LED lights.

## Between Rooms

Between rooms, the three in-room roles should be resetting for the next group of students. Reset only takes a few minutes, but should be done as quickly as possible. Tasks can be divided between the three operators any way that works for them.

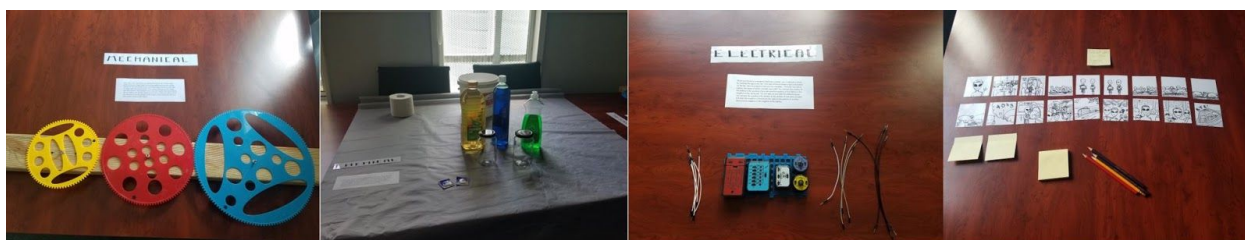
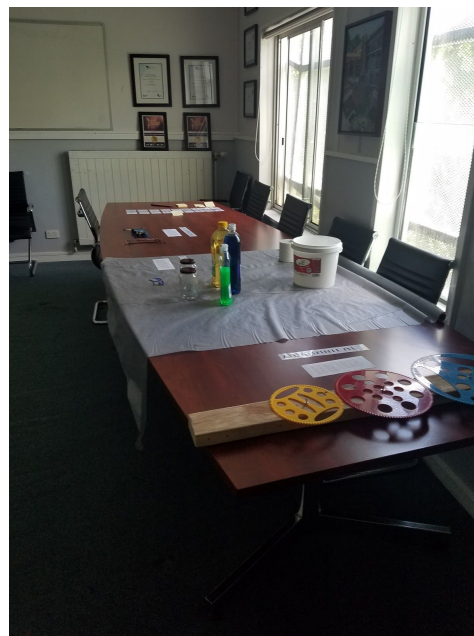
- Switch completed chemistry challenge out for chem challenge backups behind the scene. Clean up any major spills. Be sure that all components, especially alka-seltzer, are present for the next run.
- Switch floor level LEDs to dark blue with remote control.

- Switch clips on electrical challenge from the fan back to the red light.
- Hide gears under mechanical table.

## Post-Room

To set up the post room, you need to have one long table (such as the one in Gina's office) or a few smaller tables if a large table is unavailable. On this table the 4 stations need to be set up: the electrical kit, the spirograph gears, the chemistry materials and the storyboard with extra paper and markers. The order of which these are set up on the table does not matter, but it is best to keep the chemistry challenge away from the storyboard just in case any of the liquids are spilled so as not to damage the storyboard or any of the drawings. It is also best to make sure the other challenges are a good distance away from the chemistry challenge as well for similar reasons. In addition to the 4 stations, there should be a plastic table cloth to lay down on the table

underneath the chemistry challenge to make sure that spills are contained. There should also be a bucket to dump the liquids into, with a water bottle to rinse the jars out with so that the room can be reset. Additionally, there should be something to wipe up spills with (a roll of toilet paper will suffice).



Once the kids come into the room, the person running this room should say something to them about how now there is no rush and you can explore the different challenges on your own time. This is so the kids know that they can play with any or all challenges and not feel like they need to rush. Then the person in this room goes back and forth between the kids as needed helping them either solve the challenges, answer questions, or help enforce the concepts that were trying to be taught. Additionally, it is important that the person running this room is keeping a close eye on the chemistry station, as this station can get very messy and if not watched closely, liquid could actually explode out of the jars if they shook an Alka-Seltzer tablet and try to open the jar afterwards. There is also a specific way to dispose of the vegetable oil that is made much easier if the volunteer in this room is taking care of dumping the liquids and

cleaning the jars. Therefore, it is convenient for the guide to follow the students into the post room, as an extra person to help/watch. But it is not necessarily needed if they are required to be elsewhere.

In between groups, it is important that the room is reset before the next group comes in. The first step to reset the room, all the wires need to be unplugged from the electrical kit and placed on the table. Then the jars need to be emptied and rinsed/dried out. To help with easier breakdown later it is best to use a funnel and pour off the vegetable oil layer (the top layer) into a bottle (that is going to be thrown away) with a funnel. Then when all the vegetable oil is poured off into a bottle, dump the rest of the water into the bucket and use the extra water bottle in the room to rinse out all the soap from the jars and lids. Then with the toilet paper, dry it out the best you can and dry off the table as well. This is just to ensure that it is not a huge mess for the next group of kids and so every group can have the same experience of playing with these challenges. For more information on the vegetable oil disposal see [oil disposal](#) below.

## Disassembly

### Pre-Room

1. Collect role cards, props (2 puzzle pieces and 2 torches), and extra badges, place in materials bag
2. Shut down computer and projector

### In-Room

1. Disconnect Battery at back of electrical system.
2. Remove LED Strips from top of challenges. Carefully roll up.
3. Remove LED Strips from bottom of challenges. Carefully roll up.
4. Remove clips from electrical challenge.
5. All of these should go in one box.
  
6. Give Chemistry flasks to Post-Room Operator.
7. Place all other chemistry challenge components in a new box.
  
8. Store mechanical components in the same box as chemistry components.
  
9. Take wooden mechanical and electrical challenge pieces out, and store accordingly.
  
10. Fold up backdrops

11. Pile up table tops
12. Store together accordingly
  
13. Take speakers from hiding places, store with owners or in electrical/LED box.
14. Make sure the plastic bag covering the smoke detector is taken off

## Post-Room

1. Begin cleaning up once the last group has finished with the post-room.
2. Take all the wires off of the electrical kit. The wires should all be placed together and neatly rubber banded together, and then rubber banded to the board to keep from losing the wires.
3. Pick up the storyboard (keeping the pictures in order would be helpful for the set-up in future iterations of the room) and then rubber banded together.
4. Place the wires, storyboard, labels for each station, and the spirograph gears in the storage bin for the post-room materials.
5. To break down the chemistry station, empty the jars and bottles (see [oil disposal](#) below) and wash the jars in the sink with soap and water to get rid of any residual oil.
6. Place the jars (once dried), the soap, extra Alka-Seltzer tablets, and the empty water bottles (do not store the liquid in the bin in case of spills) into the post-room bin. The rest of the vegetable oil can also be saved for the next run of the room, but it is best not to store it with the rest of the items in the bin due to the chance of a spill.

## Oil Disposal

Oil cannot be dumped down the drain due to environmental concerns and the chance of clogging the pipes. The proper way to dispose of oil is to pour it into a sealable bottle and to put it in the trash. But with the vegetable oil-water mixture, water takes up a lot of space/volume and water can be poured down the drain. So, it is more space-effective to pour just the vegetable oil into the bottle and dump the water down the drain. Since oil is the top layer of the two liquids, if poured carefully you can pour all the vegetable oil into the bottle and only get a little bit of the water mixed in. This is more space-effective than storing the entire mixture in bottles, but it is not necessary. The entire liquid mixture can be disposed into bottles and thrown away if there are plenty of extra bottles available to store the liquid.