

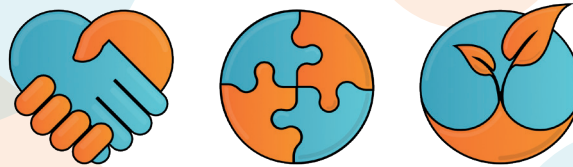
# ACES



A Community-Centred Educational Model for  
Developing Social Resilience through Play

## THE ACES STEMBUCKET CHALLENGE 2022 HANDBOOK

# ACES



## A Community-Centred Educational Model for Developing Social Resilience through Play

This handbook was compiled within Coventry University's Centre for Post-digital Cultures by Prof. Sylvester Arnab, Dr. Dominic Mahon, Alex Masters, and Mark Lewis. With thanks to our partners in Indonesia, Malaysia, and Vietnam, and all of the ACES STEMBucket Challenge 2022 participants. The ACES project is funded by the UKRI-ESRC under the Global Challenges Research Fund (GCRF).

This handbook would not be possible without your desire to change the world and passion for knowledge.



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# INTRODUCTION



This booklet showcases a collection of playful and frugal learning activities associated with Science, Technology, Engineering, and Mathematics (STEM) developed by students and teachers from Indonesia, Malaysia, and Vietnam. These activities, selected from the winning entries from the ACES StemBucket Challenge 2022, best embody playfulness, frugality, and learning.

The challenge was organised by the ACES project. ACES is an international research project and stands for 'A Community-Centred Educational Model for developing Social Resilience'. The project is funded by the UKRI-Economic and Social Research Council (ESRC) under the Global Challenges Research Fund (GCRF).

Playful and frugal considerations for designing learning experiences and resources are essential for ensuring meaningful and effective approaches to education. By making learning enjoyable and engaging, learners may be more motivated to learn and to apply their knowledge and skills. By finding efficient, resourceful, and sustainable ways to facilitate learning, teachers can make the most of time and resources and be creative with how learning resources can make use of everyday materials.

Each example within the booklet describes the playful, frugal, and learning components of the activity, accompanied by link/QR code to a video demonstrating the activity. The playful and frugal aspects of each example have been mapped visually using radar diagrams, the degrees of each aspect are based on evaluations carried out by an esteemed judging panel [page]. This booklet contains example mapping criteria [appendix] which can be used by teachers and learning designers to inform the design and evaluation of their educational activities.

Professor Sylvester Arnab  
Coventry University

# PLAYFUL LEARNING ASPECTS

Playful learning is about embedding and promoting a sense of autonomy, curiosity, and agency for learners to experiment whilst engaging with fun challenges and social interactivity.

We have created a set of guiding principles that can inform the design and delivery of your learning activities. The following values, among others, represent the interrelating characteristics that are often demonstrated in playful activities.

- **Autonomy** - Encourage the ability to take control and make decisions in the learning process. Activities, resources, or spaces allow for the freedom to explore the challenges and opportunities associated with them.
- **Fun** - Facilitate engaging experiences and affective participation through 'easy' and 'hard' fun. Easy fun is often associated with fantasy and imagination through engaging stories and gameplay. Hard fun links to our need to improve our abilities, often when tackling a challenge.
- **Agency** - Encourage learners to respond and act on challenges or opportunities during the learning process. Learners can take charge, making choices about what they do and how.
- **Curiosity** - Instil a sense of wonder and desire to explore and investigate. Encourage the need to know, the need to feel, and the need to value during the activity.
- **Experimental** - By repeatedly attempting an activity/task, multiple solutions and consequences can be explored and reflected on. Hypothesis testing can occur to discover different alternatives.
- **Social** - Social interaction is key to learning. Learners become more informed, gaining a wider perspective, and capable of making better decisions when engaging with others.

By considering and incorporating these values in your learning design, you will be able to create engaging, motivating, and meaningful activities for learners to participate in.

# FRUGAL EDUCATION ASPECTS



Frugal Education is an approach for developing creative, practical, and sustainable education design. Harnessing the power of design thinking, leveraging available resources, and building at the speed of need to deliver sustainable education practice.

Whatever you're looking to create, from in-class activities to learning spaces; teaching materials to course designs; school playgrounds to university campuses; we recommended you consider the following frugal education aspects when designing, resourcing, and developing all facets of education practice.

We have created a set of guiding principles, each broken down into three key aspects, to help you design education in a frugal way:

## Design with an Open Mind

- **Creative** – Foster experimentation, creative thinking, and problem-solving to combine ideas from different disciplines in innovative ways.
- **Collaborative** – Take an empathic approach to learning design by including the target audience in the design process, working together to co-create your designs.
- **Open** – Share your designs within the public domain, enabling others to adopt and remix your ideas into their own practice.

## Leverage Available Resources

- **Resourceful** – Take advantage of available materials, repurpose trailing-edge technologies, and reuse existing resources in new and novel ways.
- **Practical** – Identify the right tools for the job, considering the practicality, cost, and accessibility of materials and resources.
- **Resilient** - Equip your learning designs with the flexibility to adapt gracefully in response to unforeseen circumstances and environmental changes.

# FRUGAL EDUCATION ASPECTS



## Build at the Speed of Need

- **Minimal** - Keep it simple. The less complicated your design is, the easier it will be to build, deliver, and manage.
- **Sustainable** - Design with sustainability in mind to deliver environmentally responsible education practice, both locally and globally.
- **Iterative** - Start small and iterate often, through a continuous cycle of rapid prototyping, testing, and refinement.

## How can I Apply These Principles?

We have developed a deck of action cards to help you identify and apply aspects of frugal education within your own education designs. These are available for free, under an open licence, for you to download and print copies of your own.

To download a copy of the cards, scan or click on the QR code at the top of this page.



# 21st CENTURY COMPETENCIES

## 21st Century Competencies

- Analytical & critical thinking
- Active & lifelong learning strategies
- Problem solving
- Critical thinking & analysis
- Creativity
- Leadership
- Technology use & design
- Technology design & programming



Society is advancing and changing at an increasingly rapid rate. As part of this evolution, the skills required to enjoy life are also changing. This applies to the world of work as well as everyday life. It's important then that people develop skills and competencies that are useful and flexible.

When considering life in the 21st Century, a number of competencies are of particular importance. Lifelong learning and reflection allow people to understand what they need to learn in terms of their own development. Communication skills are essential to collaborate at work and with others in your community and on social media. Problem solving and critical thinking will always be essential skills to develop in order to enjoy success in any field.

One of the goals of the ACES project is to investigate how playful learning activities can develop these competencies. To begin with, as play is not typically high stakes, it can reduce stress in the classroom. Play fosters and rewards creative experimentation in solving problems. The collaborative elements of playing with others contributes to the development of communication and social skills. Play can also foster autonomy and leadership through giving ownership of the activity to the participant.

Another goal of ACES is to investigate resilience. It's likely that the development of competencies is linked to the development of resilience. The greater the set of competencies an individual has, the greater their resilience is likely to be. This increase in individual resilience in turn has a cascading positive effect on the resilience of the communities and institutions of which that individual is a member.

The development of competencies then is a positive for both the individual and society. Playful learning interventions provide a means to develop these competencies. Clearly then, play in the classroom is not just about having fun.



# ACES STEMBUCKET CHALLENGE 2022

## Introduction

In its inaugural year, the ACES STEMBucket Challenge is a multi-national competition that examines playful and frugal learning designs which address Science, Technology, Engineering, and Maths (STEM) based educational practices. It focuses on creative, sustainable, and engaging activities generated by students and teachers whilst offering substantive monetary prizes to help support future educational projects.

STEMBucket Challenge winners have been selected from each country, and a range of individual categories such as those that best embody playfulness, frugality, and learning. Additionally, there are prizes for the three best entries from across all categories.

The following pages feature the winners of each category, offering an insight into what we consider prime examples of excellent practice.

Congratulations to all our entrants.



## OVERALL WINNERS

Gold	Ejection Rocket Experiment
Silver	Learning Conductor and Insulator Through Maze Runner
Bronze	Fish Intestines Compost Block (FICOB)

## INDONESIA

Gold	Ejection Rocket Experiment
Silver	Simple Aesthetic Candle to Light the Dark World
Bronze	The Windmill of Life

## MALAYSIA

Gold	Learning Conductor and Insulator Through Maze Runner
Silver	Fish Intestines Compost Block (FICOB)
Bronze	Food Attack

## VIETNAM

Gold	Making Mini Water Filtering Tools
Silver	A Lesson for the Local Education Subject
Bronze	Muong's Language Lesson

## LEARNING

Gold	Fish Intestines Compost Block (FICOB)
Silver	Learning Conductor and Insulator Through Maze Runner
Silver	Ejection Rocket Experiment
Bronze	Simple Aesthetic Candle to Light the Dark World
Bronze	Air-Powered Toy Car with Balloons as Propulsion Motor

## PLAYFUL

Gold	Learning Conductor and Insulator Through Maze Runner
Silver	Ejection Rocket Experiment
Bronze	CHEM-P-JONG
Bronze	The Windmill of Life

## FRUGAL

Gold	Ejection Rocket Experiment
Silver	Simple Aesthetic Candle to Light the Dark World
Silver	Fish Intestines Compost Block (FICOB)
Bronze	DIY Magic Water
Bronze	Making Mini Water Filtering Tools

# STEMBUCKET CHALLENGE 2022 WINNERS

## EJECTION ROCKET EXPERIMENT



**Location:** Indonesia

**School:** SDIT Nurul Fikri

**Creator:** Faiha Zhafira Aftani

**Email:** anisafitriarahmah@gmail.com

### Activity Summary

In this experiment, we make a rocket from a paper cup that is decorated with origami paper to form a rocket with a rubber band at the bottom. The way to play it is to press the rocket down on the other paper cup and when it is released the rocket will be thrown like launching. In this experiment we take advantage of the elasticity of rubber bands to propel an object. Elasticity is the ability of the rubber to return to its original shape. The ejection rocket working principle is when we press the rocket down on the other paper cup, the rubber will stretch and have elastic potential energy. When released, the rubber will return to its original shape and change the elastic potential energy into kinetic energy that makes the rocket launch. The stronger we press the rocket down, the farther/higher the rocket launches as the energy produced is also greater.

### Learning and/or Competency Outcomes of the Activity

In this experiment, we study the simple science of elasticity, elastic potential energy, kinetic energy, and changes in energy. The stronger we press the rocket down, the higher the rocket is launched, and vice versa. We also learn that the technology used in this experiment is the elasticity. We can also find tools around us that use elasticity technology such as car suspension, bows, spring scales, spring beds, trampolines, and pens. We also teach engineering which involves students assembling parts of the rocket and attaching the rubber. We also learn simple mathematics in the form of geometric shapes. We use geometric shapes to decorate the rocket.



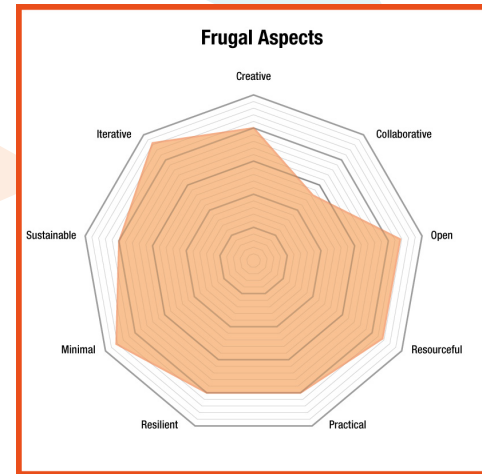
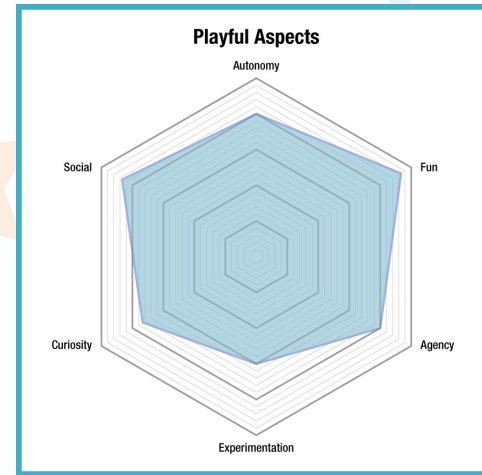
## Playful Aspects of the Activity

In doing this experiment the children will be very happy because they can freely explore decorating the rocket according to their imagination. They can also role play as an astronaut while doing this experiment. The rocket is designed very simply so that it is easy for children to assemble themselves, which will encourage pride in their work. Children are also free to play it or experiment many times to answer their curiosities, such as what is the approximate maximum height that can be reached by the rocket, how to make the rocket fly even higher by pressing deeper, or when the rubber will break when pressed. And of course, it will be more fun when played with friends, they can compete to see whose rocket has launched the furthest.

## Frugal Aspects of the Activity

The tools and materials used are very easy to find around us and the price is quite affordable. It can also be replaced with used materials to learn how to recycle. Like paper cups, they can be replaced with used plastic cups, or plastic bottles with cut ends, used cans, or used cardboard. Origami paper can also be replaced with snack wrappers or directly drawn using crayons or paints. The point is that the use of materials can be adapted to each environmental condition.

## Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS

## LEARNING CONDUCTOR & INSULATOR THROUGH MAZE RUNNER



**Location:** Malaysia

**School:** SK Batu Empat, Limbang

**Creators:** Batu Empat Primary School

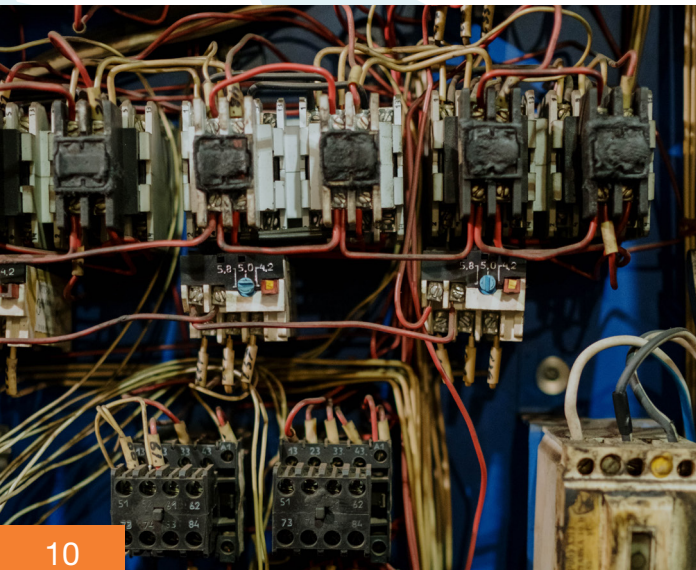
**Email:** alexbaru1102@gmail.com

### Activity Summary

The Maze Runner is aimed at tackling the lack of mastery that the students of Batu Empat Primary School have on the theory of conductors and insulators in the science syllabus. They find it difficult to distinguish between conductors and insulators theoretically in the classroom setting. Teacher-centred lessons can also lead to less effective learning. To overcome this problem, we suggest learning activities that involve games outside the classroom. Thus, the Maze game that has a playful aspect will be more interesting as students will do activities that involve physical movement. The students are required to conduct tests to practice the theory of conductors and insulators to be able to get out of the Maze. The expected learning outcome from this activity is that students can state at least four conductive materials and express the concepts of the conductive and insulating materials using the accurate terms through investigative and problem-solving activities. The Maze is built using natural branches, biodegradable netting, and recycled cardboard materials. Subsequently, this will inadvertently encourage the students to be more frugal by using nature's resources.

### Learning and/or Competency Outcomes of the Activity

The expected learning outcome from this activity is that students can state at least four conductor materials and express the concepts of conductive and insulating materials using accurate terms through investigative and problem-solving activities. We also assume that the students have recognized the way to build a complete electrical circuit. There is some scientific knowledge that the students will learn such as to observe the state of the circuit, to acquire problem-solving skills, to



predict the state of the light bulb when the circuit is connected to the conductive material, and to use and handle science equipment and materials correctly.

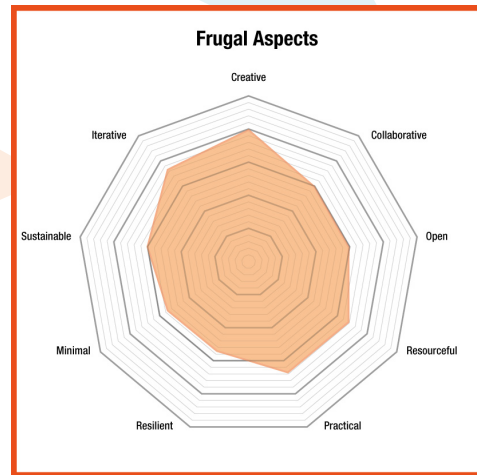
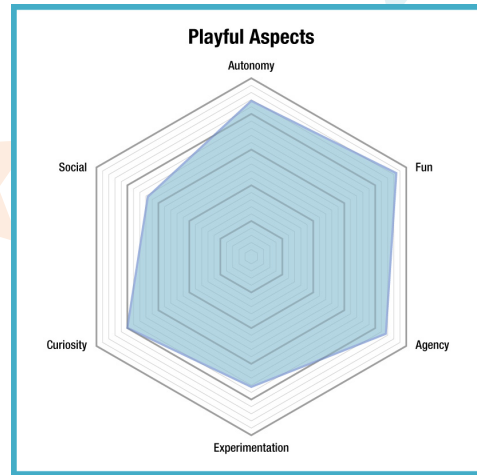
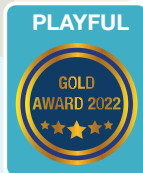
### Playful Aspects of the Activity

Through the Maze game, we wanted to highlight education through the concept of fun interactive learning. Although the learning of conductors and insulators can be done in the classroom theoretically, it will be much more interesting if the students can do outdoor activities that involves physical movement, mental excitement, and emotional thrills. The Maze game allows the students to get immediate answers on which objects are conductors or insulators by conducting several experiments through the conductor test and buzz wire. They will be instantly rewarded with a signal to show the way out of the Maze. Thus, the students can engage more frequently and with greater enthusiasm as they strive to get out of the Maze.

### Frugal Aspects of the Activity

We used natural materials such as branches from around the school grounds in the construction of this Maze. In addition, the use of black netting in the construction of the maze wall is also recycled from agricultural projects around the local area. The black net is made from material that is biodegradable and it is also an environmentally friendly material that is not like other plastics that are harmful to the environment. In addition, many recycled materials are used in the construction of conductor tests. Almost 80 percent of the materials used are surplus boxes that are no longer used. We also try to minimize the use of plastic in the creation of a project.

### Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS

## FISH INTESTINE COMPOST BLOCK (FICOB)



**Location:** Malaysia

**School:** Universiti Malaysia Sarawak (UNIMAS)

**Creators:** Megah Holdings

**Email:** laxshmi82@gmail.com



### Activity Summary

The aim is to provide a financially viable way to compost fish waste and other organic wastes in the coastal fishing community while including elements of both playful learning and frugal education approaches. We learned that fishing is a significant source of revenue for the population in the quaint village of Pasir Pandak, and dried fish (ikan salai) is one of their primary products for sale. Large amounts of fish waste, including intestines, which are frequently tossed into the compound, add to the odour, and have an impact on hygiene. Crocodiles and monitor lizards are the usual scavengers attracted by these inappropriate fish wastes. The main outcome is the use of fish waste as a composting material to stimulate economic growth. The problem aligns with SDG 1.5, which aims to empower the villages to take problems into their own hands by composting trash for their vegetable gardens and fruit orchards. Further income from this can be generated to end poverty. The use of compost as a crop fertiliser might eliminate the need for artificial fertilisers, resulting in increased crop yields that would ensure the farmers' village's food supply and consumption is sustainable (SDG Target 12.5).

### Learning and/or Competency Outcomes of the Activity

Through this activity, students will successfully show how to collaborate with others from different fields to discover a practical solution to an issue that has been recognised in the nearby coastal community. To support the objectives of producing new and long-lasting results, this activity promotes a rich interaction across academic disciplines. The assignment sharpens the learners' creativity as they come up with concepts for creating a prototype out of materials that are easily accessible. The primary result of the activity is the use of the waste

produced from the fish as a source for compost, which can promote economic growth by turning trash into a useful good.

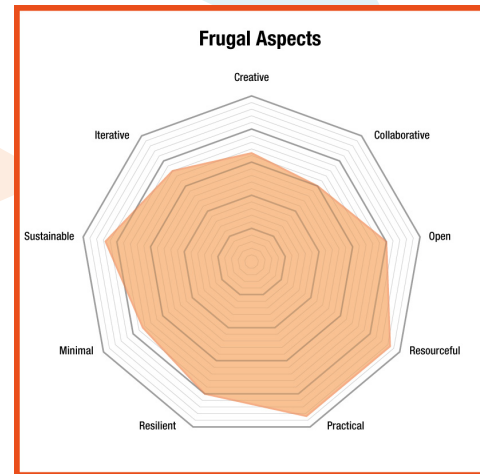
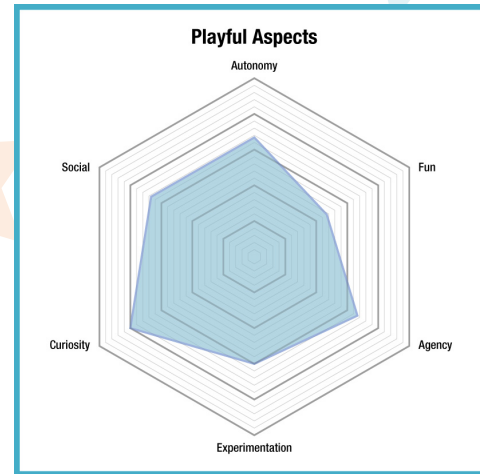
### Playful Aspects of the Activity

This method is crucial for creating fun, low-tech composting tools to let kids work with adults and learn how to compost their fish waste while having fun. Fish guts, earth, organic waste, and water were combined to create the compost within a plastic bottle with drainage holes. These items will gradually be transformed into compost that can be used. Compost will be cut into blocks of a specific size to make it more convenient to stack, more space-efficient, and compact. Additionally, the block-sized compost may be stored for a longer shelf life.

### Frugal Aspects of the Activity

Smart, easy-to-implement solutions are what frugal innovations are all about. By putting the theory into practice, it is proposed to manufacture compost using widely available materials and ingredients such plastic bottles, fish waste, organic waste, and water. Composting at home is possible if you use readily available materials. Our approach is to set up a proper composting area utilising inexpensive products that are readily available in the village, as the major objective is to promote a realistic composting concept for the inhabitants of Pasir Pandak. Fish waste can therefore be utilised to produce new compost every few weeks, which the farmers can use as needed.

### Winning Categories





# STEMBUCKET CHALLENGE 2022 WINNERS

## MAKING MINI WATER FILTERING TOOLS



**Location:** Vietnam

**School:** Lipica Kindergarten

**Creators:** Nguyen Lan Huong, Nguyen Thu Phuong  
& Cao Huyen Chang

**Email:** lipicaxala@gmail.com

### Activity Summary

Water pollution is an issue in many parts of Vietnam, so we aimed to introduce a way to make mini water filtration tools for kindergarten students to get to know about the importance of clean water. We used easy-to-find and low-cost / no-cost materials including recycled plastic bottles, porous cloth, clean cotton, fine sand, and pebbles to conduct our experiment. Students were instructed to justify and make final decisions on the order of materials used as well as on the amount of each ingredient needed to construct the water filtering tool. When working in groups, they could confidently take on tasks and support each other. They were very eager to wait for every drop of clean water to flow down the water catcher and shouted out happily when their task was completed. Students could also learn a valuable lesson, thinking carefully before taking action when pouring water too quickly and forcefully causing water to spill out.

### Learning and/or Competency Outcomes of the Activity

Students understand the importance of clean water and environmental protection. Besides, they are also trained in taking care, patience, solidarity, and support for each other.



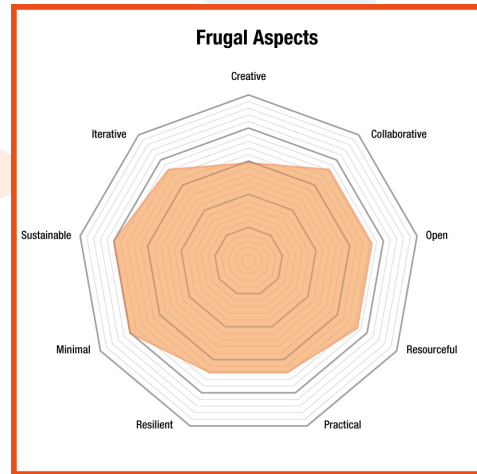
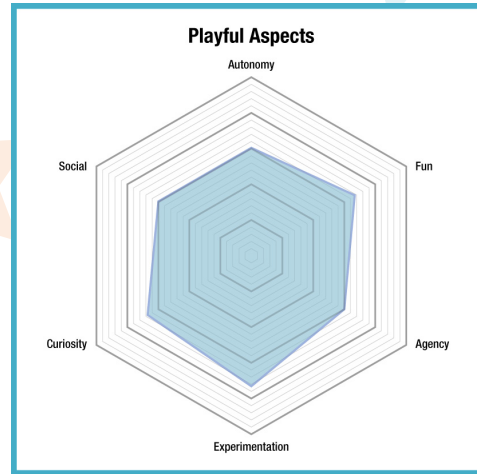
### Playful Aspects of the Activity

The students take control and make decisions within the activity. When working in groups, they would confidently take on tasks and support each other. Students would also learn a valuable lesson of being careful and thinking carefully before taking action.

### Frugal Aspects of the Activity

We used easy-to-find and low-cost / no-cost materials including recycled plastic bottles, porous cloth, clean cotton, fine sand, and pebbles to conduct our experiment.

### Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS

## SIMPLE AESTHETIC CANDLE TO LIGHT THE DARK WORLD



**Location:** Indonesia

**School:** SDIT Akmala Sabila Cirebon

**Creators:** Muhammad Khalis A'ufa Suyudi

**Email:** lipicaxala@gmail.com

### Activity Summary

Prolonged rainy seasons can have both positive and negative impacts on society. They often cause flooding and power outages that interfere with community activities, especially if they occur at night. There have been many forms of lighting technology, such as flashlights, emergency lights, etc., that can be used in the event of an outage. However, many people still use simple lighting such as candles. Candles are cheap and easy to obtain. However, we sometimes forget where we put our candles or even run out in the event of a sudden power outage. These problems can be overcome by making simple candles from improvised materials that are easy to find. Materials and tools that can be used to make emergency candles include cooking oil, water, glass cups, cotton buds, or cotton. Used cooking oil is one of the raw material wastes in the household environment which has a negative impact on body health and the environment. Therefore, it is necessary to make efforts to turn used cooking oil into something useful, minimizing waste cooking oil and reducing environmental pollution. The purpose of this activity is to increase students' knowledge of the impact of using and disposing of used cooking oil on their health and the environment.

### Learning and/or Competency Outcomes of the Activity

Increasing students' knowledge about the impact of using and disposing of used cooking oil on health and the environment. Increasing a students' knowledge of products made from used cooking oil, namely simple aesthetic candles. This increases skills in making simple candles by using used cooking oil as a basic ingredient. The results of this activity can be observed directly after the activity is carried out. Waste cooking oil is used for daily activities and even has the potential to help



in illuminating environments when there is a power outage at night. Students can also observe that oil absorbed in the cotton bud can make the flame last longer.

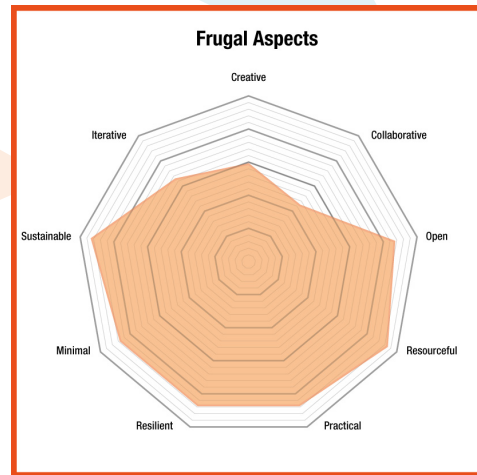
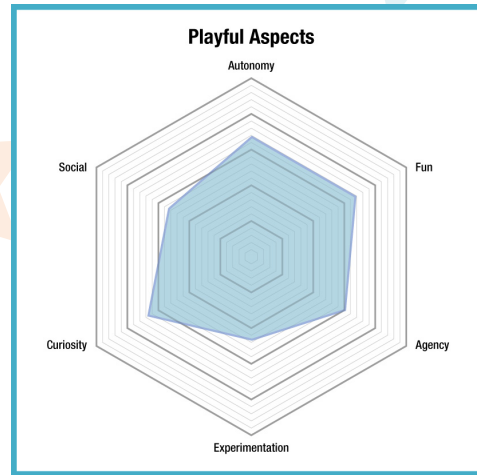
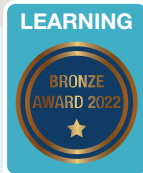
### Playful Aspects of the Activity

In the experiments that have been carried out, students can find out that cooking oil will not mix with the water. This is because water molecules are polar. Oils, on the other hand, have nonpolar molecules that have no charge. Therefore, oil molecules are attracted to other oil molecules, not water molecules, making the two immiscible. Used cooking oil can be repurposed as an alternative energy source for lighting. Lamps made from used cooking oil can replace other sources such as candles, flashlights, and kerosene lamps. With the conclusions that students have made, the lamp wick can light up when lit, the lamp wick can light up brightly, and the flame from the wick can last long enough before the cooking oil runs out.

### Frugal Aspects of the Activity

How to make simple aesthetic candles from simple materials that are easy to find? Materials and tools that can be used to make emergency candles include used cooking oil, water, glass cups, cotton buds, or cotton. First, put the marbles in a glass cup and place the cotton buds in the middle of the marbles so that the cotton buds stand upright. Next, put the water into the glass, filling it to 50% of the glass, then add the used cooking oil into the glass. You will see that used cooking oil does not dissolve and separates from the water. After all the materials have been assembled, a simple emergency candle has been created for use in the event of a power outage.

### Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS

## A LESSON FOR THE LOCAL EDUCATION SUBJECT



**Location:** Vietnam

**School:** Nguyen Tat Thanh High Quality Practical School

**Creator:** Bui Van Thanh

**Email:** thanhhb1988@gmail.com

### Activity Summary

Each province in Vietnam has its own characteristics of culture, history, geography, economy and society... Therefore, for many years, the content of Local Education has been included in the curriculum that aims to help students better understand the land they live in. There is no fixed curriculum or syllabus for this subject, as it depends on the reality and conditions of each district and even each school. Therefore, teachers, myself included, may find it difficult to address the given teaching task. They would like to be supported particularly in terms of pedagogical approach and curriculum development. This video cannot capture all the sessions in my lessons, but for me it can best represent my attempt and readiness. I conducted a lesson with some local games (hand-made ball passing and traditional bowling), which had hardly been seen in my teaching previously. I gave students more time to enjoy playing and working together, not just as formal learning in the classroom. Then I asked the students to choose the task they would like to do, and they could negotiate and seek help from various sources.

### Learning and/or Competency Outcomes of the Activity

Thanks to the training provided by ACES Vietnam, I have become more aware of Playful and Frugal aspects. I have become more familiar with designing/co-designing a learning activity, following Design Thinking. I started from the change in my mindset, with which I was ready to adapt a minor part of my lesson and learn how to reflect on my teaching. Then I tried to apply the new pedagogical approach to create different versions of my teaching plans, then worked with the students and listened to their feedback. I know it takes me much longer to 'digest' the new knowledge, but I am willing to make changes. By the end of the



lesson, my students could revise the knowledge of the local festivals, traditions, several major historical sites, and typical features of Hoa Binh Province. More importantly, they were happy and proud of their exploration as well as their collaboration in completing a learning task.

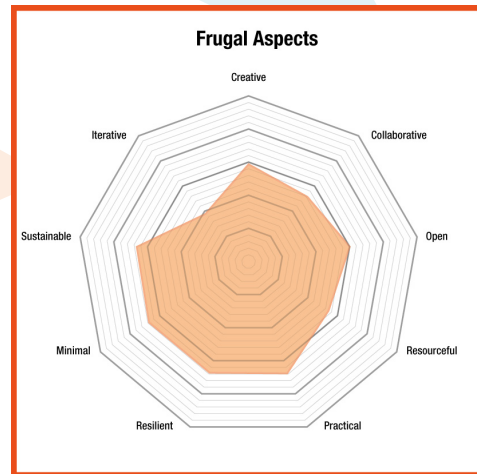
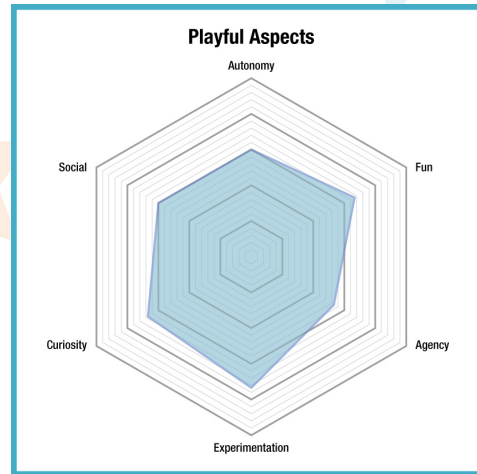
### Playful Aspects of the Activity

My students have more time to enjoy playing and working together. They can decide which task they would like to do, and they could negotiate and seek help from various sources. They were happy and proud of their exploration as well as their collaboration in completing a learning task.

### Frugal Aspects of the Activity

We make use of the school's existing facilities and recycled materials to create this fun class.

### Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS



## THE WINDMILL OF LIFE

**Location:** Indonesia

**School:** SDN Kanyoran 2

**Creators:** Khusnul Niken & Rizky Julia Putri

**Email:** kanyorandua@gmail.com

### Activity Summary

Education involves contact between educators and learners utilizing a variety of methods and learning models to enable comprehensive learning towards real life application. STEM approaches and learning models, based on specific contexts and environments, are now becoming viable options for improving the quality of relevant learning for learners. Khusnul Niken and Risky Julia Putri of SDN 2 Kanyoran, Kediri Regency, East Java, Indonesia, conducted an experiment entitled "The Windmill of Life" in the ACES STEM Bucket Challenge; an activity using the STEM (Science Technology Engineering Math) approach within the concept of change motion energy that produces electrical energy to light miniature houses.

### Learning and/or Competency Outcomes of the Activity

The Science element of this project teaches students about natural laws and concepts, such as electric charges generated by electromagnetic induction in a dynamo powered by a windmill. The technology aspect is the use of an artificial tool that can facilitate activities, such as joining cardboard using a glue gun. The concept of a miniature windmill rotating to drive a dynamo to generate power demonstrates engineering concepts, including techniques to solve a problem. The mathematical aspect is demonstrated by measuring the length of the cardboard, which is cut as needed, as well as the combination of flat and volumetric shapes.



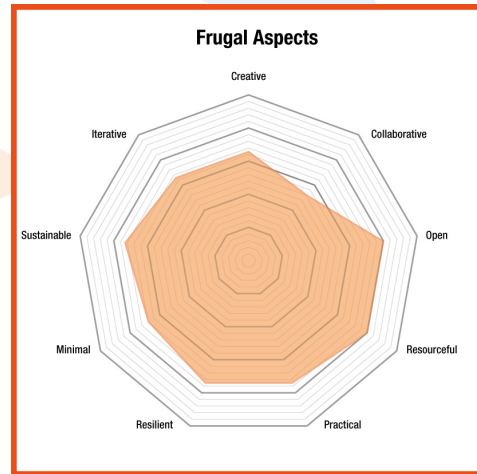
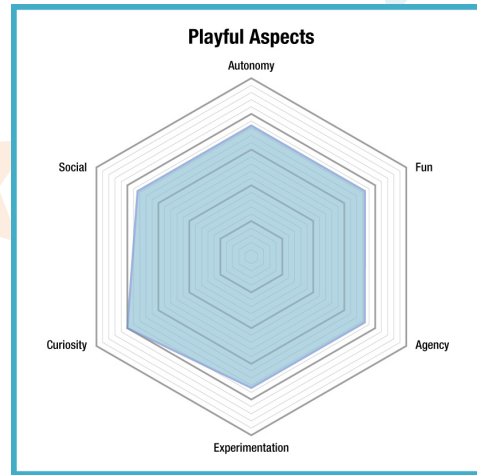
### Playful Aspects of the Activity

Apart from the use of STEM approach, it must also be playful and frugal. We assume that the experiment we are conducting, entitled The Windmill of Life, would be a lot more fun and easier to accomplish because the concept is straightforward and applicable to learners within the age range of the Aces STEM Bucket Challenge. Furthermore, our operations are cost-effective, as we source the majority of our materials by recycling available materials, such as used dynamos and cardboard. This game provides a playful atmosphere when children put their creativity into arranging each component and collaborating with both parents and their peers to develop solutions.

### Frugal Aspects of the Activity

Our operations are cost-effective, as we obtain the majority of our materials from second-hand sources, these include used dynamos and cardboard. Utilizing second-hand materials can reduce waste in the local environment and maximize usefulness of existing materials. The utilisation of used items is aligned with the frugal criteria within in the ACES STEM Bucket Challenge criteria, honing children's creativity by utilizing materials around them. The tools used are also easy to find at low prices. Enabling children to do this activity at a very low cost.

### Winning Categories





# STEMBUCKET CHALLENGE 2022 WINNERS



## FOOD ATTACK

**Location:** Malaysia

**School:** Sekolah Kebangsaan Mentu Primary School

**Creators:** The FracMen

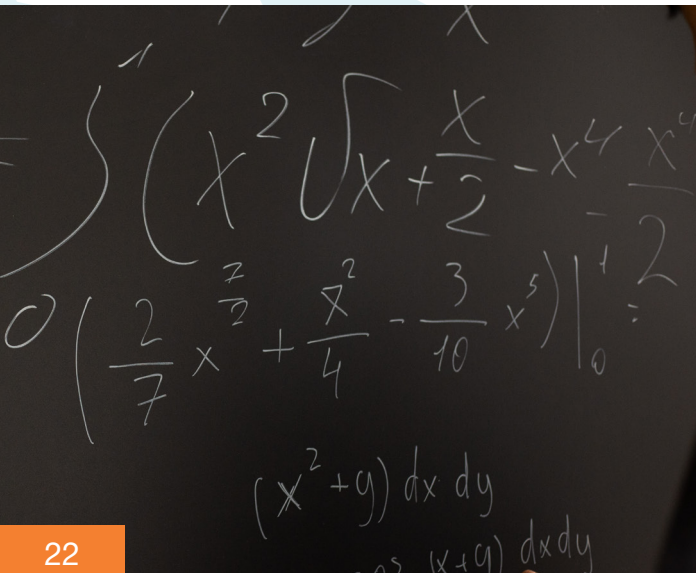
**Email:** aliyonnamagdalene@gmail.com

### Activity Summary

The FracMen is an innovative team from SK Mentu, Simunjan, Sarawak. Our team members consist of two teachers and three pupils aged 11 to 12. Our team has created a card game known as Food Attack. The idea of developing the Food Attack game was inspired by the card game Heart Attack. The aim of the Food Attack game is to help primary school pupils enhance their skills in solving mixed operations such as addition and subtraction involving whole numbers, proper fractions, and mixed numbers. This game can be used as an activity to teach Mathematics for primary school pupils during practice and production stages of teaching. Our team selected food as the theme for this game because pupils are more familiar with the topic, and the visualisation of food to represent fractions can ease the pupils' understandings. In addition, pupils also learn about the application of fractions in their daily lives when doing this activity. Therefore, we truly hope that the game, which we proposed in this project, will help to ease both teachers and pupils in teaching and learning the targeted topic. We aspire to provide a solution to make learning fractions more enjoyable and interactive for the pupils.

### Learning and/or Competency Outcomes of the Activity

At the end of the intervention using the Food Attack game, pupils should be able to: determine the fractions by looking at the picture of coloured parts of the food; change the denominator of two or more fractions by doing multiplication or division; convert whole numbers into proper fractions or mixed numbers; add two or more numbers involving whole numbers, proper fractions and mixed numbers; subtract two or more numbers involving whole numbers, proper fractions and mixed



numbers; and solve mixed operations of addition and subtraction involving whole numbers, proper fractions, and mixed numbers.

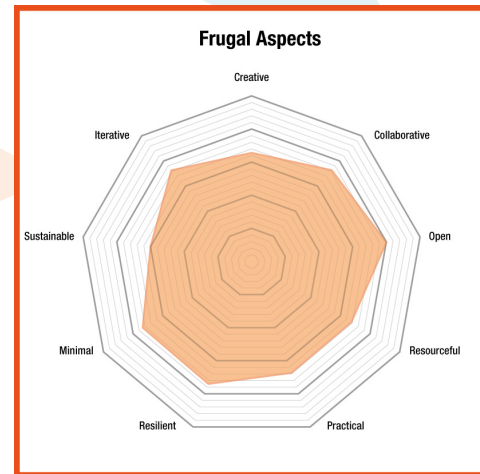
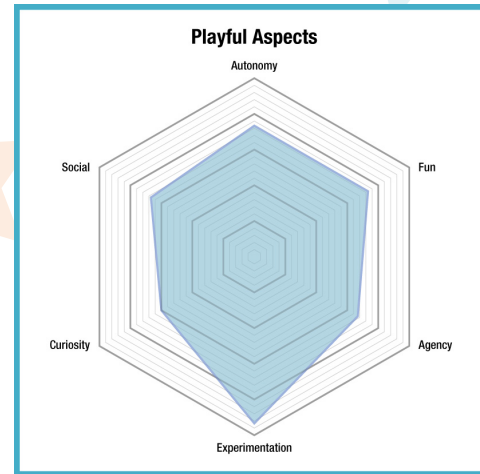
### Playful Aspects of the Activity

Food Attack is a structured-play learning activity because teachers set the rules and clear learning objectives for the pupils. This game is very much student-centred as pupils will play individually in a group of four and the teacher acts as moderator. When playing the game, the pupils are involved in active participation and spontaneously choose the questions using the digital spinner. Pupils will subconsciously gain problem-solving skills involving the addressed mathematical problems and experience decision-making when doing this activity as they carefully choose the right card before matching it with the answers. Lastly, this game is fun and motivating because pupils compete with their peers to win the game.

### Frugal Aspects of the Activity

Food Attack game is a frugal activity as we use a very minimal budget. First, our team creates the cards using the back of used papers, printing them in small sizes to minimise the printing cost. This saves more paper. By doing this, we can also lower the laminating cost as we can laminate up to 12 pieces of card using a single piece of film. Next, Food Attack is a low-budget project because we use Microsoft PowerPoint to make the digital spinner. Lastly, the designs for the cards are drawn by the pupils themselves. Overall, the cost of producing a set of the Food Attack game is as low as MYR 2.00.

### Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS

## MUONG'S LANGUAGE LESSON



**Location:** Vietnam

**School:** Nguyen Tat Thanh High Quality Practical School

**Creator:** Le Thi Thu Huong

**Email:** p.qlkh.c23@gmail.com

### Activity Summary

Muong Language is a group of dialects spoken by the Muong people of Vietnam, primarily spoken in mountainous regions of the northern Vietnamese provinces including Hoa Binh Province. Aligning with Vietnamese Ministry of Education and Training (MOET)'s 2018 national curriculum, Minority Language Education aims at developing students' competence of local minority languages as well as promoting various ethnic cultures across the country. For this reason, Muong language is a mandatory language subject in Hoa Binh. This 45-minute lesson was conducted with Grade 7 students at the Green Playground in Nguyen Tat Thanh School. The lesson focused on Muong female costumes, with their typical colours and traditional features.

The lesson featured a sequence of 4 major activities. The first one titled 'We are Muong people' in 5 minutes, aiming at dividing students into 3 Muong groups: Muong Bi, Muong Vang and Muong Dong. The second 10-minute activity, Discovering Muong female costumes, helped students to recognise the spelling, pronunciation and meaning of the words. They could write down and speak the words about some common Muong Clothes for females. Next comes controlled practice when the students were asked to look at a picture of Muong women in traditional costumes and describe the costumes regarding the type of clothes and colour. Finally, each group followed instructions in different points at the playground (representing the stream, bridge, Muong house, etc.) in the escape game to collect materials so that they could design and create the Muong clothing items. Their final product was the presentation of their design in a poster, and they used the target



language (vocab and sentence patterns) to describe the clothing items in their poster.

### Learning and/or Competency Outcomes of the Activity

By the end of the lesson, students were able to gain an insight into the Muong ethnic language and culture. Specifically, they could understand the Muong language of the given theme and could use the language to describe the costumes. One more follow-up activity as homework is that students were asked to design a Muong clothing item for their female family members. They would bring their design to the next class for a gallery walk and presentation.

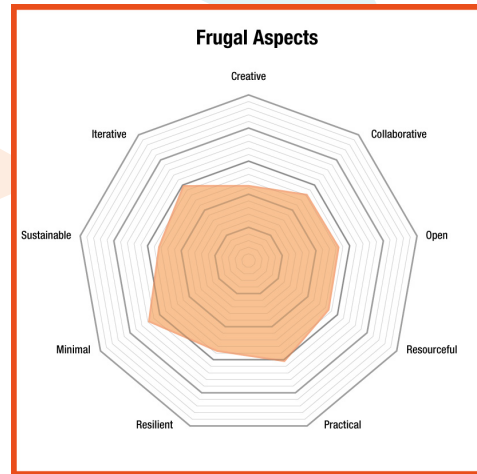
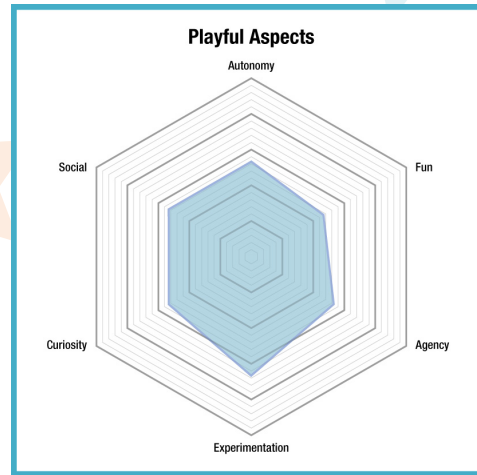
### Playful Aspects of the Activity

The students successfully collaborated with each other in a series of playful gamified activities at the Green Playground and co-designed the clothing items, using frugal resources. Finally, they could present their product with confidence and great joy.

### Frugal Aspects of the Activity

The teachers took advantage of the school's available facilities to organize lessons for the students as well as using easy-to-find and low-cost/no-cost materials for students to design costumes.

### Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS

## AIR-POWERED TOY CAR WITH BALLOONS AS PROPULSION MOTOR



**Location:** Indonesia

**School:** SDIT Akmala Sabila Cirebon

**Creator:** Maliq Al Rayyan Putra Pradith

**Email:** bayuibrahim51@gmail.com

### Activity Summary

Environmental health becomes more important each year, and quality of life is very dependent on the cleanliness of the ecosystem. However, plastic waste that continuously accumulates is slowly becoming a problem that must be resolved. Plastic waste seems simple, but the spread of unorganized plastic waste from can damage many habitats, through the sea, land, and as air pollutants. Recycling plastic waste into items that can be reused is one solution that can be used to overcome the existing waste problem. One example is making a toy car from a plastic bottle, which is powered by air. Air will be collected in the balloon as propellant for the toy car. With this balloon-powered toy car, students will be more curious and have fun learning and using this media. Because this is an experiment about air, and compressed air as a propellant, this balloon-powered car is a fun science project to work on with the kids. This activity also teaches participants about recycling and how to turn used goods into fun toys. Toy cars can be made using tools and materials that are easily found. The balloon is the motor that drives the speed of the car. When it is filled and released, the air will be forced out, the balloon will shrink back to its original shape, and the air coming out of the balloon will propel the car forwards.

### Learning and/or Competency Outcomes of the Activity

By applying this experimental method to car game activities, it is our aim to present learning for students through experimentation. Experimenting and proving for themselves something is being learned, as well as teaching students how energy or air can be used to propel objects. Promoting student abilities to solve problems they may face



through the use of scientific methods, so that students can learn skills for solving challenges they may face. Students gain scientific knowledge through practice, the aim is that information obtained is based on scientific principles. The information presented is the result of findings and formulations that are objective and in accordance with the rules of physics.

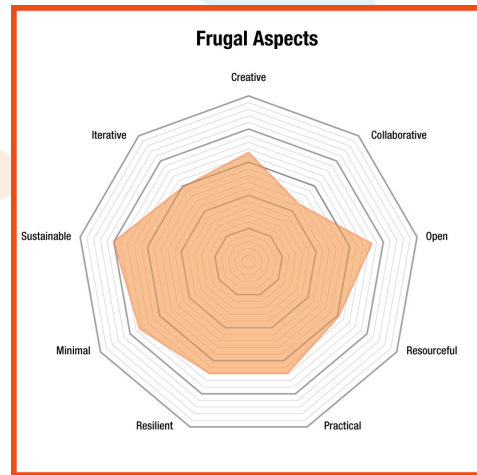
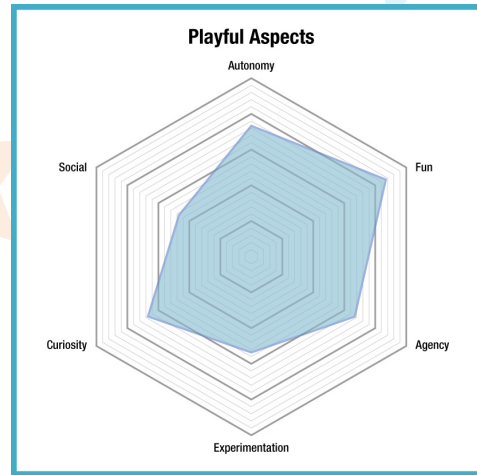
### Playful Aspects of the Activity

With the toy car game, learning for students is more fun, because the balloon and car are closely related to the students' favourite toys. Students also believe more in the truth or conclusions of their own experiments. In this case, students are able to use fine motor skills and senses in various ways. Students are also able to recognize the concept of scale, distance, and measurement using non-standard measuring instruments. This activity also enables students to carry out further experiments using the principles they have learned by making air-powered toy cars.

### Frugal Aspects of the Activity

Tools and materials used in this activity, such as solder, glue, plastic straws, plastic bottles, bottle caps, balloons, skewers, marker, and string, are easy to find in the local environment or school. This is a very cost effective method for making this toy car. This activity is more sustainable because it relies on used materials. With the toy car game, teachers can apply innovative learning for students to make new breakthroughs by discovering the results of their experiments, while benefiting the natural world through the recycling of materials. This activity is a good lesson about recycling and how to turn used goods into educational activities in an affordable and sustainable way.

### Winning Categories



# STEMBUCKET CHALLENGE 2022 WINNERS

## CHEM-P-JONG

**Location:** Malaysia

**School:** SMK Pujut, Miri

**Creators:** Hedrawati Mohamad & IT GIRLS Team

**Email:** hedra3015@yahoo.com



### Activity Summary

Game Based Learning (GBL) helps students harness their cognitive thinking skills to get answers. Chem P-Jong is an interactive game created to help chemistry students in SMK Pujut better understand particles. This game is not competitive in nature but rather a fun way for students to learn a desired concept. From the study we carried out, it is evident that Chem P-Jong helps students better grasp the conceptual learning of particles and how to categorize them to atoms, molecules, and ions, compared to the conventional teaching and learning methods carried out in class. This game is effective, especially on students who achieve lower than average as it can attract and lengthen their attention span. Apart from having fun, students are able to learn faster and, in a short span of time, learn the fundamental concepts which contribute to building the bigger framework of learning. This game is totally reusable for many other subjects and suitable for the current way of learning.

### Learning and/or Competency Outcomes of the Activity

Recognising numerous types of particles and familiarising with thousands of chemical formulae is fundamental for understanding chemistry subjects. Chem-P-Jong game-based instruction has the potential to increase student engagement and chemical skill development. Because the children are repeating matches, the chemicals formulae, and identifying thousands of ions, molecules, and atoms, the game exercises their brains. In the past, learning concepts were sharpened and disclosed through a lot of writing activities. When learning is enjoyable, challenging, and engaging kids are more likely to appreciate studying chemistry and be inspired to learn more about it.



The games are designed to help kids learn and enhance their abilities either before or concurrently with studying chemistry.

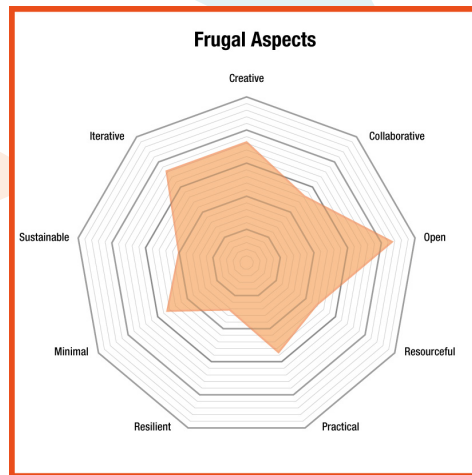
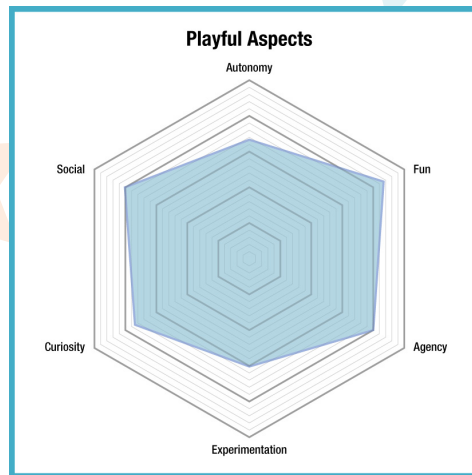
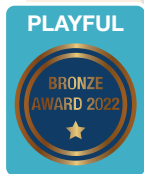
### Playful Aspects of the Activity

Have a moment of peace to calm your mind and boost your brain instead of learning traditionally in class. Sharpen your mind with a series of particle matching levels that gradually increase in difficulty. Playing Chem-P-Jong for 10 minutes a day sharpens the mind and prepares you for daily life and its challenges. Challenge yourself with this addictive mahjong-inspired game where the goal is to match 2 types of formulae with types of particles and clear the board. Puzzles will help to strengthen our understanding of the numerous formulae of ions, molecules, and atoms. Increase mindfulness, exercise your brain, and take control of your daily life through meditative puzzle games.

### Frugal Aspects of the Activity

Chem P-Jong was adapted from the traditional e-Mahjong game. Hence it was easy to be used by the players. We are planning to expand this game to different concept learning in Chemistry and other subjects such as Physics and Biology. The adaptation to different subjects is absolutely free. We are also hoping to make this game available for the students from different schools in our region. By doing so we believe the interest of students in STEM related subjects will be heightened, which is vital in producing workforces for Industry 4.0. Besides that, by sharing this game with all schools we will be able to improve the quality of education, which is also the 4th Sustainable Development Goal (SDG) addressed by United Nation (UN).

### Winning Categories





# STEMBUCKET CHALLENGE 2022 WINNERS

## DIY MAGIC WATER



**Location:** Malaysia

**School:** University Malaysia Sarawak (UNIMAS)

**Creator:** Nur Ardini binti Noh

**Email:** ardininoh020209@gmail.com

### Activity Summary

This design is called “DIY Magic Water” as we can see that the initial water is brown, and when the water goes through the “DIY Magic Water” the colour changes to crystal clear and clean water. The basic concept of this design is it acts as a filtration system. It drives us to be more creative in making the filtration system as we can use other materials, such as sand and ground charcoal only, and charcoal, gravels, pebbles, cotton or coffee filter and other varieties materials that are suitable. This innovation functions to provide clean water to the user as water is the most important basic source for life on Earth. It also can be used when we are in an emergency, where the filtration system at our home is broken or in any other emergency. Thus, this design is environmentally friendly as it uses natural materials that can easily be found. Also, the costs are very cheap as we do not need investment to buy the materials, except for the coffee filters. Even so, the coffee filter is optional as we can use a clean cloth in its place.

### Learning and/or Competency Outcomes of the Activity

This innovation teaches me indirectly the STEM concept where we can relate Science by identifying all the functions of the materials used, such as charcoals that are used to absorb the odour from the water sample. Technology can be seen by the efficiency of the “DIY Magic Water” works; engineering is apparent when combining the materials, deciding which should be at the top and bottom of the system; and Mathematics when cutting the bottles and measuring all the materials needed to make sure the system functions well.



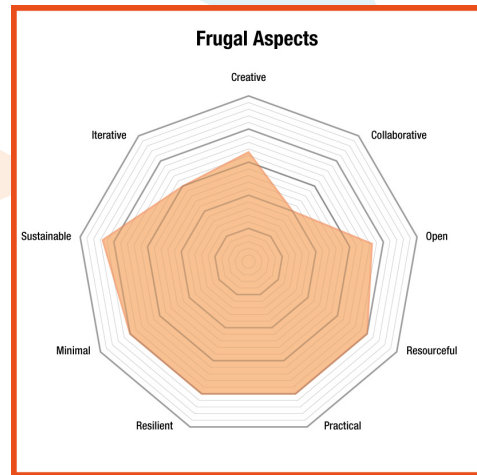
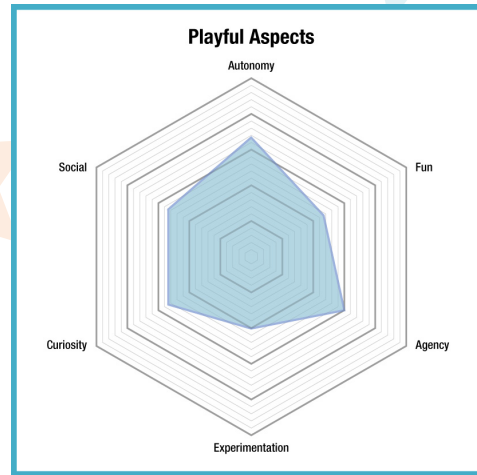
## Playful Aspects of the Activity

This design is very fun to do together, and the materials used can vary. People of all ages, especially students and kids, can take part in this design process. It can be used as a competition held in school to help students and kids to think creatively, making them able to discuss and communicate their thoughts and ideas about the order of the filtration system. The name “DIY Magic Water” itself is already fun, which can trigger the students and kids to know more about what things are and how it is working.

## Frugal Aspects of the Activity

This design was inspired by myself and my team during our camping last year. During that time, we only had dirty water and had run out of drinking water. Due to the situation, an idea came to my mind and this design was invented. Thus, all the materials used are easy to obtain and it is environmentally friendly as we can repurpose used bottles to create the “DIY Magic Water” activity. Besides, I believed that this design can be expanded widely and can be very useful for the future. This design does not require any investment for the materials used.

## Winning Categories



# STEMBUCKET CHALLENGE 2022

## ADDITIONAL ENTRIES



### **Walking Water**

Jeehan Fatimah Asyakirah  
SDIT Ummul Quro Bogor, Indonesia



### **Water Purification**

Ruby Sesang Nur F  
SDIT Al Lauzah, Indonesia



### **Pumice boat**

Bayanaka Adyastha Kusuma Putra  
SDN 1 Mangkujayan, Indonesia



### **Science Experiment to Make a Microhydro Power Plant Miniature**

Absi Mahandika Zuchri  
SDIT Al Mubarak Jakarta Pusat, Indonesia



### **Simple Fountain**

Shafwan Nauval Nuruddin  
SDIT Akmala Sabila Cirebon, Indonesia



### **Water (Water Wheel), Fire (Rainbow Candle), and Air (Air Bubbles)**

Radinka Zahsy Ayunindya Riyanto  
SDN 1 Pelem, Bungkal, Indonesia



### **STEM Port**

Arantxa Venessa Anak Derahim (Merapokians!)  
Sekolah Menengah Kebangsaan Merapok,  
Malaysia



### **Vitamins on Mission**

Eric Tang Tien Yong (Dollar Bills Team)  
SMK Limbang, Malaysia

# STEMBUCKET CHALLENGE 2022

## ADDITIONAL ENTRIES



### **Interactive Lecturer Approach**

Yuan Meng Yong  
SMK St Columba, Miri, Sarawak, Malaysia



### **Pest Control Monitoring System**

Neutron  
Universiti Malaysia Sarawak, Indonesia



### **Identifying the Direction**

Pham Thi Thu Hang  
Nguyen Tat Thanh High Quality Practical  
School, Hoa Binh Province, Vietnam



### **A Lesson on Vietnamese Medicinal Plants of the Muong Ethnic Group in Hoa Binh Province**

Nguyen Vu A Sa  
Nguyen Tat Thanh High Quality Practical  
School, Hoa Binh Province, Vietnam



### **Getting to Know 6th Grade**

Quach Thi Thuy Thien  
Nguyen Tat Thanh High Quality Practical  
School, Hoa Binh Province, Vietnam

# STEMBUCKET CHALLENGE 2022

## COMPETITION JUDGES



**Nicola Whitton**  
Professor of Education at Durham University

Nicola Whitton is Director of the Durham Centre for Academic Development and Professor of Education at Durham University. Her research focuses on play in adulthood, in particular games and learning in the context of Higher Education, and the potential of play in teaching, research, and academic practice. Her most recent projects have focused on the potential of escape room design for learning.



**Tom Gorman**  
Academic and Theatre Director at Coventry University

Tom Gorman is an academic and theatre director currently based at Coventry University. He is a Senior Lecturer on the BA Theatre and Professional Practice Degree at Coventry University. His work with the University of Tampere, Finland on immersive rehearsal spaces won prestigious Gold Awards from Reimagine Education in 2016 and 2018. Tom has since been a judge for the Reimagine Education Awards 2019-2022.



**Ann-Louise Davidson**  
Professor of Education at Concordia University

Dr. Ann-Louise Davidson is the Director of the Concordia University Innovation Lab and Concordia University Research Chair in Maker Culture. She is also Associate Director of the Milieux Institute for Arts, Culture, and Technology and directs #MilieuxMake, the Milieux makerspace initiative. She is the creator of Education Makers, a research group who works at the intersection of maker culture, social innovation, pedagogical transformation, and empowerment. Her children story book Amber the Maker has been supported by the Canadian Commission for UNESCO and has been translated in ten languages.

# STEMBUCKET CHALLENGE 2022



## COMPETITION MARKING CRITERIA

### Overview

Each of the entries within the ACES STEMBucket Challenge 2022 was graded using a series of aspects, which you can view on this and the following two pages. Each of the aspects was given a score between 0 and 5 with a score of 0 indicating that an aspect had not been met, and a score of 5 indicating it had been met fully. The scores were then added up to give an overall total and the winning order determined. For a more comprehensive instrument that can be used to assess your designs, please scan or click the QR code, top right of each section.

## PLAYFUL ASPECTS

### Autonomy

Encourage the ability to take control and make decisions within an activity. The activity usually allows for the freedom to explore the challenges associated with it.

### Fun

Facilitate engaging experiences that can evoke emotionally driven participation. There are two main types of fun, which are easy and hard. Easy fun is often associated with fantasy and imagination through engaging stories and gameplay. Hard fun can be linked to our need to improve our skills, often when tackling a challenge.

### Agency

Encourage learners to respond to and act on challenges during the activity. Learners can take charge, making choices about what they do and how.

### Curiosity

Instill the sense of wonder and the need to explore and investigate. Encourage the need to know, the need to feel, and the need to value during the activity.

### Iteration/experimentation

Allow multiple “tries” of the same task. By repeatedly attempting an activity, multiple solutions and consequences can be explored and reflected on. Hypothesis testing can occur to discover different alternatives. Learning through play should lead to developing greater degrees of flexibility, tolerance, and reflection.

### Social

Social interaction is key to learning. Learners become more informed, gaining a wider perspective, and are capable of making better decisions when engaging with others.

# STEMBUCKET CHALLENGE 2022

## COMPETITION MARKING CRITERIA



### FRUGAL ASPECTS

#### **Creative**

Seek inspiration from disparate sources when creating or expanding upon your design. Combine ideas, techniques, and concepts from different disciplines in innovative ways. Foster experimentation, creative thinking, and problem-solving within your participants and incorporate their insights into future iterations of your design.

#### **Collaborative**

Great learning design is achieved through collaboration. Include your audience in the design process; the earlier the better! Listen to your audience, encourage participation, and be empathetic to their needs, concerns, and suggestions for improvement. Use what you learn to co-create the learning design with those it is designed to serve.

#### **Open**

Share your designs by making them freely available within the public domain for the benefit of all. Allow others to apply, adapt, and build upon your work through clear and detailed guidance. Make your designs easily discoverable, accessible, and openly licensed through the power of Creative Commons.

#### **Resourceful**

Leverage available resources that can be sourced from your local environment and wider community. Recycle, upcycle, and combine materials and trailing-edge technologies in new and inventive ways, extracting untapped value and extend their lifespan. Inspire your students by promoting a culture of resourcefulness.

#### **Practical**

The latest gadgets and educational fads are great and everything... but are they the best tools for the job? Consider the practicality of your design; the technologies and materials required; the physical and virtual spaces you inhabit; the intellectual and physical accessibility; and the financial and human resource costs of delivery.

#### **Resilient**

Sometimes technology fails, spaces are unavailable, and global pandemics grind life to a halt. Equip your designs with the flexibility to adapt gracefully to unforeseen circumstances.

# STEMBUCKET CHALLENGE 2022

## COMPETITION MARKING CRITERIA

### FRUGAL ASPECTS CONTINUED

#### Minimal

Be economical with the resources that constitute your design. Look to reduce administration, streamline processes, and minimise costs. The simpler your design, the easier it will be to build, deliver, and manage. Freeing up valuable resources that can be used to better serve your learners.

#### Sustainable

Whether designing from scratch or adapting existing practice, consider the wider impact of your design on the environment. Think about the first-order effects of your design decisions and how they might impact the local environment. Now zoom out and consider the second-order effects of your design from a global perspective.

#### Iterative

Don't overthink it. Start small and iterate often. Test the effectiveness of your design through rapid prototyping, giving you the flexibility to respond quickly and effectively to the needs of your audience. Design, resource, build, and deliver quality education through a continuous cycle of improvement and refinement.





# ACES



A Community-Centred Educational Model for  
Developing Social Resilience through Play



The ACES Project is funded by the UKRI-ESRC under the Global Challenges Research Fund (GCRF).  
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