

# **Gamifying STEM: Teachers' Training Programme**

## **An ACES Malaysia Case Study**

### **Introduction**

The teachers' training programme intends to pioneer educators for a new generation of STEM education utilising playful co-creation approaches to teach STEM in the area of Science, Mathematics, Design and Technology, Physics, Chemistry, and Biology. The programme targets schools in Sarawak's urban, rural, and remote districts. The program aims to link STEM instruction to 21st-century competencies. From the programme, the capacity and abilities of educators are expected to grow as a result of the implemented playful co-creation of projects and experiences.

Resources and Internet connectivity are currently scarce in schools in rural and remote areas. In Sarawak, 83% (1215 out of 1458) of schools are in rural and remote areas. These schools are frequently overlooked and given lower priority when it comes to accessing facilities and resources. When there aren't enough resources, teaching and learning can be challenging. A lack of hands-on labs, for instance, would make it difficult to teach science in schools. And this would contribute to students having low learning motivation, which would then affect how they performed in STEM subjects.

In the ACES teachers' training programme, the playful co-creation method created a fresh perspective based on project-based learning and experiential learning approaches for developing learning competencies and innovation in line with the 5E learning model and being frugal. The strategies and techniques employed are intended to have an impact on students who receive STEM education, which will also help with the development of skills, such as critical thinking and problem-solving, communication and collaboration, creativity and innovation. In the long term, the students will grow and be in a better position to contribute and add values to the production of their communities, regions, and countries in the fields of R&D and innovation, which are essential for both economic and social growth.

### **Scope / Define**

Teachers' training using the STEMBucket programme that incorporates playful, co-creative and frugal approaches to develop 21st-century learning competencies, and STEM-based innovative projects.

### **Target Groups**

The target groups are Sarawak State Education Department (JPNS), Teachers Training College Batu Lintang Campus (IPGKBL) and schools in Sarawak, and teachers received the educational programme.

The project involved over 5,000 participants:

- 650 teachers from all 31 districts in Sarawak.
  - 62 teacher coaches from 31 schools in Sarawak.
  - Over 20 teacher coaches (JU from DLP)..
  - Over 20 administrative teachers from JPNS and IPGKBL.
  - Over 4,000 attendees and viewers for webinars.
- Stakeholders: Universiti Malaysia Sarawak, senior management in Sarawak State Education Department (JPNS), senior management in Teachers Training College Batu Lintang Campus (IPGKBL), all the thirty-one selected top public schools, and all District Education Office (PPDs) in Sarawak.
  - Industries: Chumbaka, Exploria.
  - NGOs: #Demilaut, Time To Rice.

## **Project Team**

- Researchers from universities: Universiti Malaysia Sarawak
- NGOs: The Kalsom Movements, Time to Rice, #DemiLaut,
- Industries: Chumbaka, Exploria
- Partners: Sarawak State Education Department (JPNS), Teachers Training College Batu Lintang Campus (IPGKBL)

## **Aims**

To engage teachers and trainers in the co-creation and ownership of the educational process while promoting empowerment and agentic practice through playful, cost-effective (frugal), and reflective teaching strategies in the learning program.

## **Main Design & Delivery**

A teacher training programme was developed to advance knowledge and skills and enhance teachers' professional growth. The programme used playful co-creation and gamification strategies to empower instructors to build lesson plans and innovative activities that would improve STEM skills, apply STEM, design and innovation activities, conduct research, develop products, and create innovations. At the end of the day, the programme was made to give students a better learning environment.

### **1. Concept**

Knowledge: Pre- and post- survey on the knowledge on specific topic/content during the workshop or activities.

Skills: Practical hands-on capability and efficacy skills and soft skills.

Abilities: Decision-making, critical thinking, problem-solving, innovation and reflection.

### **2. Playful and Frugal**

**Playful:** Experiential learning through fun play, curiosity, autonomy, agency, social interaction.

**Frugal:** Resourceful, resilience, minimalism, sustainability, creativity, practicality, collaboration.

### 3. Co-creation

Methods: Needs assessments and analysis, Game Design Thinking, Experiential Learning, 5E learning model and co-creation, Reflection Model, co-owned, emergent Design Thinking, Participatory Action Research (PAR), Building of trust (using top down and grassroots approach), collaborative towards belonging, sense making (analysis).

### Sustainable Development Goals Addressed

- [GOAL 4: Quality Education](#)
- [GOAL 11: Sustainable Cities and Communities](#)
- [GOAL 15: Life on Land](#)

### Timeline

The project ran over a period of 3 months, from August – October 2022.

### Locations

- **Sibu**, Sarawak, Malaysia.
- **Mukah**, Sarawak, Malaysia.
- **Bintulu**, Sarawak, Malaysia.
- **Limbang**, Sarawak, Malaysia.

### Key Lessons Learnt

In order to incorporate STEM education into the national education system, training teachers who are innovative, productive and equipped with 21st-century competencies is a necessary step.

Strategies:

- Training teachers who are innovative, productive, and equipped with 21st-century abilities was a key step made in incorporating STEM education into the national educational system.
- Working with ministries, industries and NGOs by leveraging on their network and also cast a wider net of a variety of audiences.
- Promotion of national education policies coherent and comprehensible in terms of initial academics training.
- Propose several scenarios of training routes for future academics.

- Establish an independent institution - Gamification Centre, as an alternative to professional development training.
- Ensuring the necessary skills through both theoretical and practical training in accordance with the quality standards for the teaching profession.

## **Practical and Policy Recommendations**

- Playful pedagogies should be incorporated into the national education curriculum at all levels, from primary to secondary school, and will be recognised as a valid and valuable approach to learning.
- Schools and educational institutions should be encouraged to create a positive and inclusive learning environment that promotes social resilience and playful pedagogies, including through the provision of adequate resources and facilities for play-based learning.
- Collaboration with community organisations and other stakeholders be fostered to support the integration of playful pedagogies into the Malaysian education system and to promote the benefits of these approaches to parents and the wider community.
- Develop guidelines and resources for teachers on using playful pedagogies in the classroom, including training and professional development opportunities.

## **Impact**

- A Memorandum of Understanding was signed with Chumbaka (in 2021).

## **Detailed activities**

### **Activity 1: PAK 21 (21st-Century Education) workshops in collaboration with Jabatan Pendidikan Negeri Sarawak (JPNS)**

#### **Scope**

The sessions focused on fostering participants' creativity, empathy, and inclusive pedagogical practices. This connected them to global concerns including youth social resilience and how teachers' roles align with the goals of 21st-Century Education and the United Nation Sustainable Development Goals (SDGs).

#### **Target group/Beneficiaries**

Primary and secondary school teachers from all divisions in Sarawak, JPNS.

### **Project team**

- Researchers from universities: Universiti Malaysia Sarawak.
- Partners: Sarawak State Education Department (JPNS).

### **Aims**

To emphasise social resilience and the 21st-century teaching and learning competencies by incorporating the Sustainable Development Goals (SDGs) into the Malaysian educational context.

### **Concept**

- Needs assessment and analysis – SWOT, Risk matrix, Action Plan and strategy, Social Resilient questionnaires, and interview.
- Ministry of Education partnership with ACES facilitators - energising with a shared vision, building trust, openness, and mutual concerns, building process to the vision together.

### **Playful and Frugal**

**Playful:** experiential learning through play and gamification as a creative, emphatic and inclusive pedagogical practice, Curiosity, Role-play, Game Design Thinking, Fun using these toolkits - Sticky notes and Mahjong papers, What's Your Story cards, Lego © Serious Play, PLAY toolkit.

**Frugal:** Leveraging on existing resources (resourceful), remix game items and images in the design of the gameplay to build creativity and data collection (resilience, creativity, practicality, collaboration).

### **Co-creation**

Design Thinking, teacher-centered, building of trust with the teachers and empower the teachers, collaborative towards belonging, sense-making (analysis).

### **Lesson learnt and strategy**

The methodology used in the workshops:

- The follow-up approach by JPNS with the teachers is missing.
- The success of the following methods (SWOT, Risk Matrix, Action Plan) used in the workshop for needs analysis.

Outcomes from the workshops:

- There were many concerns from the teachers regarding the lack of resources, materials and qualified teachers teaching specific STEM courses.

- In Sarawak, there are about 1,000 schools that are dilapidated and unsafe for both teachers and students - this is a concern and how can we co-design and co-create spaces in schools.

Strategies for the team:

1. the need to identify champions among teachers.
2. proposal of the STEMBucket activities for the students and teachers.

*Activity 2: STEM webinars in collaboration with the Institute of Teacher Education Batu Lintang Campus (IPG KBL)*

**Scope**

This webinar introduces current ideas and trends in the STEM field. It offers opportunities for participants to reflect and re-examine their roles and pedagogical approaches in alignment with the development of the national STEM education scene.

**Target group**

Primary and secondary school teachers in Sarawak, Institute of Teacher Education Batu Lintang Campus (IPGKBL).

**Project team**

- Researchers from universities: Universiti Malaysia Sarawak.
- Partners: Teachers Training College Batu Lintang Campus (IPGKBL).

**Aims**

To introduce emerging pedagogical trends in teaching STEM subjects, the concept of gamification and Frugal STEM Education.

**Concept**

Building partnership with IPG KBL and ACES facilitators – energising with a shared vision, building trust, openness, and mutual concerns, building process to the vision together.

**Playful and Frugal**

**Playful:** culturally inclusive view of agency, effective learning of specific conceptual content and a digital tinkering space that encourages question-asking,

curiosity, persistence, engagement in discussion and sharing interests between the facilitators, speakers, and the real world.

**Frugal:** openness in the structure of the content deliberately linking to a culturally inclusive perspective that entails self-reflection in thoughts (also linking to co-creation), fluidity in self-learning and reflecting.

### **Co-creation**

Self-regulated and making sense, agentic is able to think of ways to solve problems or do new things,

### **Lesson learnt and Strategy**

Lessons:

- The need to collaborate with the partners who might influence and impact policy recommendations.
- Use technology to attract a large audience and number of participants.

Strategies for the project team:

- Building trustworthy collaborations with partners, emergent processes from the first collaboration.
- Leverage on contacts from partners, and the use of technology and social media.
- The introduction of frugal and co-creation contents, Reflection Model.
- Further collaborate with IPG KBL.

Outcomes:

- the webinar meant for Sarawak audiences has reached the whole of Malaysia including the Malaysia STEM Association and the international STEM Association with over 4,000 viewers in YouTube and Facebook Live.
- Built trust with IPGKBL with UNIMAS.
- The outdoor components of the online learning environment are becoming more significant and prevalent, especially during pandemics that would adversely influence the learning experience (this link also applies to the ACES space in Case Study 3).

Impact:

- Strong relationship was established with the Institute of Teacher Education Batu Lintang Campus (IPGKBL) which paved the way for more joint ventures.

Activity 3: Dual Language Programme (DLP) workshops in collaboration with the Institute of Teacher Education Batu Lintang Campus (IPGKBL) and Sarawak State Education Department (JPNS)

**Scope**

The STEMBucket programme is about ‘learning by doing’ with the concept of ‘learners’ journey’ of experiences within educational settings that is influenced by scientific thinking. The partnership between the university with the local teacher training college (IPG) and the ministry of education, could act as a driver for change within educational settings, with an aim to minimise the gap in the learning experience among learners. The focus on experience could give teachers a voice in the current traditional teaching and embrace the playful experiential learning of STEM subjects.

Teachers' higher-order thinking skills (HOTS) may be developed when they receive training in the co-creation and delivery of lesson plans and other content, which is in accordance with the 21st-century learning approaches used to educate STEM.

**Target group**

Primary and secondary school teachers in Sarawak, JPNS, IPG KBL.

Total: 620 schools in Sarawak involved in the workshops.

**Project team**

- Researchers from universities: Universiti Malaysia Sarawak.
- Partners: Sarawak State Education Department (JPNS), Teachers Training College Batu Lintang Campus (IPGKBL).

**Aims**

- To connect the 21<sup>st</sup>-century skills and STEM education using both English and Malay languages in Sarawak through experiential forms of learning using play under the STEMBucket programme.
- Learning by doing the activities, and improving through reflection.

**Concept**

- Invoke competitiveness and motivation through experiential learning.



- A hybrid of the scientific thinking model and reflection model by incorporating playful, frugal and co-creation values.
- Building partnerships with IPGKBL, JPNS and ACES facilitators – to support innovative strategies, accelerate educational development programmes, and collaborate on evaluation study?

### **Playful and Frugal**

**Playful:** experiential learning through play and gamification as a creative, emphatic and inclusive pedagogical practice, Curiosity, Role-play, Game Design Thinking, Fun using these toolkits - Sticky notes and mahjong papers.

**Frugal:** openness in the structure of the content deliberately linking to a culturally inclusive perspective that entails self-reflection in thoughts (also linking to co-creation), fluidity in self-learning and reflecting (Creativity, collaboration, openness, practicality, resilient, minimalism, sustainable).

### **Co-creation**

Building of trust (using top down and grassroot approach), collaborative towards belonging, sense making, fluid learning by doing, ownership, reflecting inner learning.

### **Lesson learnt and Strategy**

Lessons:

- The need to work on the pre- and post study after every activity/workshop.
- The younger teachers have a strong degree of support for the STEMBucket initiative.

Strategies for future workshops/collaboration:

- Future collaboration with the university on a research symposium to enhance teachers' skills.
- Use grassroots tactics to test the JU-STEMBucket in a few schools.
- Continue to prod, nudge and foster a positive relationship with IPGKBL and JPNS to advance the STEM agenda in the state using the JU-STEMBucket.

Outcomes from the workshops:

- Over 600 teachers from Sarawak attended the workshops.
- Over 600 participants completed a pre- and post-survey on their understanding of a certain topic or material, capability, motivation, and efficacy.

- For the STEMBucket programme to continue, the District Education Office (PPD) must establish the primary coach or local teacher champion (known as JU) idea in schools.
- Next to do is to produce a JU-STEMBucket framework for schools.

#### **Activity 4: Reskilling and upskilling teachers with industries and UNIMAS**

##### **Scope**

Increase motivation, quality, and capability of delivery STEM subjects by enabling upskilling of teachers through higher order thinking skills (HOTS) using technologies to build innovations and to cater for Gen-Z and new-age learners. Rapid upskilling of new competencies on existing teachers' content co-creation and design skills with the integration of digital technology amid the worldwide pandemic.

##### **Target group**

- Primary and secondary school teachers in Malaysia, Sarawak State Education Department (JPNS), Chumbaka Sdn Bhd, Exploria, educators from local universities in Malaysia.
- Stakeholders: Educators from University Malaysia Sarawak, the Swinburne University of Technology Sarawak Campus (SUTS).
- Industries/NGOs: Chumbaka, Exploria, IEEE Sarawak Subsection.
- Schools: 59 selected schools by Chumbaka.

##### **Project team:**

- Researchers from universities: Universiti Malaysia Sarawak.
- NGOs: The Kalsom Movements, Time to Rice, #DemiLaut, IEEE Sarawak Subsection.
- Industries: Chumbaka, Exploria.
- Partners: Sarawak State Education Department (JPNS), Teachers Training College Batu Lintang Campus (IPGKBL).

##### **Aims**

- To innovate teaching methodologies to ensure continuous professional development.
- To upskill technical skills and capability to prepare students for a dynamic future.

- To minimise the gap between schools, universities, and industries.

### **Concept**

Using the gamification approach to invoke motivation, and competitiveness through experiential learning.

### **Playful and Frugal**

**Playful:** experiential learning through play and gamification as a creative, emphatic and inclusive pedagogical practice, Curiosity, Role-play, Game Design Thinking, Fun using these toolkits - Sticky notes and mahjong papers (Fun, curiosity, experiential, social).

**Frugal:** openness in the structure of the content deliberately linking to a culturally inclusive perspective that entails self-reflection in thoughts (also linking to co-creation), fluidity in self-learning and reflecting (Creativity, collaboration, openness, practicality, resilient, minimalism, sustainability).

### **Co-creation**

Design Thinking, Participatory Action Research (PAR), Building of trust (using top down and grassroots approach), collaborative towards belonging, sense making (analysis).

### **Lesson learnt and strategy**

Lessons:

- It is necessary to collaborate with already-established organisations to organise more upskilling initiatives for youths.
- The capability and knowledge need to be pre- and post-studied. Additional analysis must be developed.

Outcomes from the workshops:

- Research collaborations with other partners (Malaria Research Centre).
- Sustainability awareness workshops with the UNIMAS Sustainable Centre.
- Research grants awarded ((i) CREAMMS\_22: Creating a Malaria-Mindful Society by UCS and (ii) Integrated Solar Lighting and Camera Surveillance System for Kpg Pasir Pandak by IEEE SIGHT).

Strategies for future workshops/collaboration:

- Gamification Center will serve as a platform and a hub for gamification and gamified learning activities, collaboration, spaces, and new products (Stembucket, etc.) involving educators, students, industry, NGOs, and other

university partners. It will also serve as a resource platform for professional development training and human resource interns.

- Continuous collaboration for future research/partnership with industries and partners.