The STEAM Design Process

21st Century Skills Development

Starfish Country Home School Foundation

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Design Process

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The STEAM Design Process:
21st Century Skills Development

In memory of

Dr.Richard P. Haugland

Foreword

Learning in today's world has changed a lot over the last decade amid social complexity in all dimensions. Due to modern technology that has made education management more convenient and accessible, learning to adapt (especially by those in educational circles who have to take a new role and change their thinking process in learning management) is doubly important. A "teacher" is no longer the one-way knowledge provider, and school or learning units will become a common space for knowledge exchange between teachers and students through innovation, processes or new methods that are applied from textbooks, lessons, or personal experiences.

The book "The STEAM Design Process: 21st Century Skills Development" is divided into two parts. The first part introduces readers to theoretical knowledge. Then, the second part shows concrete examples from actual practices by seven school-level practitioners, proving the fact that "teachers can do", with learning processes designed to suit each school's context.

Although STEAM Education is a process mainly focusing on science, technology, engineering, art, and mathematics, teachers who completely understand their roles and put the theory into practice, as well as adopt the process as a learning facilitator's tool, are able to apply this process to all subject groups, all levels, and with all fellow teachers. Therefore, this book is connecting readers to easily "know, see, and understand", as the editor team presents the essence of skills and characteristics that have been proven to meet learning indicators in practice, before inviting readers to follow through the STEAM Design Process, which is another type of learning cycle that can develop both the learning managers and the learners at the same time.

Thanks to Starfish Education and all participating schools for their support in the Teacher School Quality Program (TSQP) or "School Quality Improvement" by the Equitable Education Fund (EEF), which has brought about outcomes that can be used as models and inspiration. Therefore, this book is another valuable force that will drive the country's educational quality development to achieve success.

Dr. Udom Wongsing
Director of the Office of Teachers, Students, and Educational Institutions Quality Development
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Preface

Education in the 21st century must develop learners, not to be good at memorizing but instead to be able to discover their interests and potential, which are the essential foundation of their self-development and lifelong learning. Educational managers have to create a classroom environment that allows the learners to own their learning and be able to practice and build learning experiences by themselves, which will develop meaningful knowledge and skills directly to the learners.

The STEAM Design Process is a Design Thinking tool developed in 2017 by the author, to be a learning tool for activities in the Makerspace, a Starfish Maker project. Learning through Makerspace activities encourages learners to practice the design thinking process to solve problems rationally and systematically. In this creative space, learners can learn according to their interests or choose any problem topics they want to solve, and use the provided space, equipment and materials to experiment and create a model or an invention as they desired to meet their own context as well as that of their community. This method focuses on STEAM education, which integrates science, technology, engineering, art, and mathematics, in many different types of learning activities according to the context of learners, school, and community.

This book provides diverse examples of STEAM Design Process learning activities in the Teacher School Quality Program (TSQP) by the Equitable Education Fund (EEF) and the Starfish Education, demonstrated by teachers who play the role of a learning facilitator as well as the learners who happily own their learning. These voices are worth learning from and sharing to inspire and encourage the development of country's new generation.

Thanks to the teachers and all students for taking the readers along to join in their classroom learning. Also, thanks to the Equitable Education Fund (EEF) for supporting and initiating the project in order to improve the quality of education and reduce Thailand's inequality.

Dr. Nanthaporn Janchalia Seributra

CEO of Starfish Education

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Chapter 1

Knowledge for the Development of Learning Management

Essential 21ˢᵗ Century Skills for Learners

Since having stepped into the 21ˢᵗ century, the world has been facing changes in every dimension of society, especially technological advancement that has become a part of daily life. Research and analysis by educators and professionals in various industries are focusing on a new set of skills such as creativity, innovation, critical thinking skills, social skills and emotional skills. These are essential skills that children need in order to work effectively in the modern world, and keep learning under any changing circumstances of the environment and society.

Essential skills and desirable characteristics of the 21st century learner include:

1. Creativity and innovation - An ability to think, design and try new things. The indicators are as follows:

- Be able to think agilely and flexibly, and provide different types of answers in various ways
- Be able to creatively apply and relate newly learned knowledge to existing knowledge
- Be able to present new and unique ideas that are different from others
- Be able to apply various knowledge and thinking methods to create new work
- Be able to create and use innovation effectively

2. Critical thinking and problem solving

- Critical thinking is the ability to think about information and analyze data rationally before making a decision. Problem solving is the ability to analyze problems, find the root cause, figure out the solution, and make constructive decisions to creatively solve problems in any situation. The indicators are as follows:

Critical Thinking

- Be able to think critically about what has been read, heard, and watched that will lead to decision making
- Be able to consider various information and link it to thinking processes.
- Be able to apply knowledge to a systematic thinking process that will lead to decision making
- Be able to reasonably argue, contend, or support
- Be able to present ideas and thoughts from what has been read, heard, or watched, and apply them to real life

Problem Solving

- Be able to analyze problems by connecting multiple perspectives and concerning all critical issues
- Be able to identify a wide variety of alternatives and solutions
- Be able to summarize knowledge to choose a solution reasonably
- Be able to choose a solution that covers all critical issues
- Be able to choose a solution that is suitable for the situation

3. *Collaboration, teamwork and leadership* - The ability to work as a part of a team. The indicators are as follows:

- Be able to express different ideas and various talents that lead the team to success
- Be able to accomplish assigned tasks and be responsible for required duties within a deadline
- Be able to work as a team, share opinions and suggestions on the tasks.
- Be able to set working goal with the team
- Be able to set working plan with the team

4. *Communications, information and media literacy* The indicators are as follows:

- Be articulate in spoken and written language, as well as with body language
- Be able to discuss, exchange opinions, and answer questions with others
- Be able to answer a teacher's and other people's questions clearly and to the point

- Be able to express thoughts by using media such as posters, mind maps, videos, animations, etc

- Be able to prepare presentations to the teacher and friends by using easy-to-understand language

- Be able to pass on information and communicate with friends via email, blogs, Facebook, Line, iMessage, or other communication applications.

- Be able to communicate and follow up with teachers via email, blogs, or other communication applications

5. *Self-awareness* - An ability to understand oneself by knowing one's own proficiencies, abilities, strengths and weaknesses, understand individual differences, and have a sense of self-worth. The indicators are as follows:

- Be able to express interest and pride in something

- Be able to demonstrate skills and talents

- Be able to participate in activities according to personal interests

- Be able to identify personal strengths and weaknesses

- Be assertive to show personal thoughts, feelings and performance

- Be able to accept other people's thoughts, feelings and performance

- Be motivated to achieve success and inspired to reach the goals

6. *Self-management* - An ability to take responsibility fir one's own behavior, understand and be aware of one's own emotional state, and adjust some behaviors that may cause undesirable emotions. The indicators are as follows:

- Be able to complete assigned tasks even if they are difficult or do not match preferences
- Be able to manage time effectively
- Be well prepared to handle any possible situations
- Be able to plan ahead in order to complete tasks on time
- Be able to express feelings properly in different situations
- Be able to control emotions and feelings in different situations
- Be able to analyze and choose proper activities/methods that contribute to self-happiness
- Be able to put off or restrain desire even if it is against personal demand
- Be able to properly use a set of words to describe emotions, such as disappointing, exciting, angry, frightening, awkward, etc.

7. *Responsible decision making* - An ability to determine the impacts of one's own decisions on both oneself and others. The indicators are as follows:

- Be able to analyze possible situations before and after making a decision
- Be able to know what is right and wrong
- Be able to consider different approaches to solve problems
- Be able to solve problems caused by personal decisions

8. *Relationship skills* - An ability to understand other people's perspectives, emotions and feelings, convey one's own feelings through verbal and body language, and foster working collaboration with others. The indicators are as follows:

- Be able to listen to others attentively and aware of a speaker's feelings and needs.
- Be able to comply with group / class / social agreements and rules
- Be able to work with others smoothly and successfully
- Be courageous to confirm good thoughts, feelings and reasons with others
- Be polite to classmates
- Be polite to teachers
- Be able to care about other's feelings

9. *Social awareness* - This includes caring for others, understanding society, being aware of living ethics, and being concerned about family, school and community.

The indicators are as follows:

- Be able to understand differences in beliefs and cultures
- Be able to learn from other people's opinion
- Be a caring classmate
- Be able to accept and respect others
- Be kind, generous and public-spirited
- Be able to follow common rules, such as queuing up to buy goods or using the restroom

10. *Life and Career skills* - An ability to live and work successfully according to the philosophy of the sufficiency economy, specified by the program. The indicators are as follows:

- Be able to discover a favorite career
- Be able to learn and practice basic career skills
- Be able to make personal income and expense reports.
- Be able to apply and further develop knowledge into a career
- Be able to apply the philosophy of the sufficiency economy to everyday life
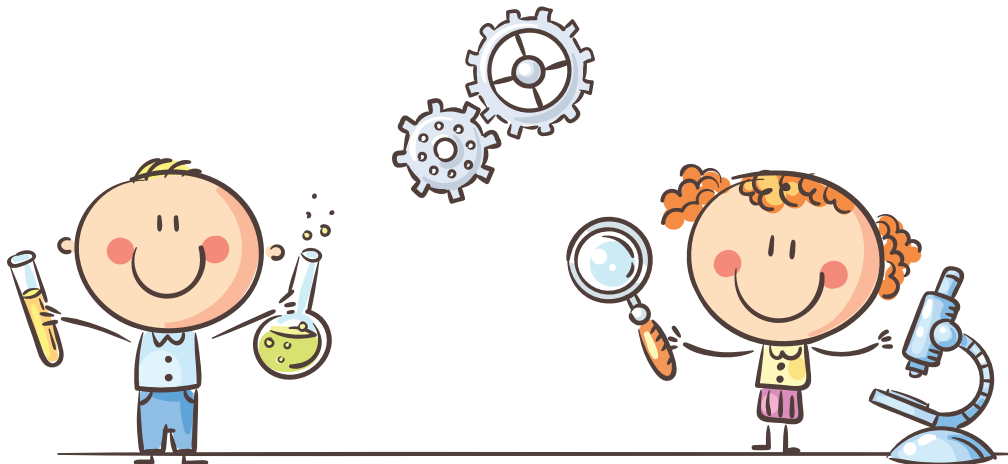
The character qualities of the learner include:

1. _Be disciplined_ - This quality demonstrates a commitment to agreements, rules and regulations of family, school and community. The indicators are as follows:

- Have self-management skills and be responsible for personal decisions
- Comply with agreements, rules and regulations of family, school and community without violating other people's rights
- Be on time for all daily activities
- Be responsible at work and be a good role model

2. _Be honest_ - This quality demonstrates a commitment to integrity and truthful acts towards oneself and others physically, verbally and mentally. The indicators are as follows:

- Be honest with oneself and others physically, verbally and mentally
- Be concerned of righteousness, and be ashamed and afraid of wrongdoing
- Treat other people with honesty and avoid exploitation

3. _Be public-minded_ - This quality demonstrates an active engagement in activities or situations that benefit other people, communities and society, without expecting anything in return. The indicators are as follows:

- Have relationship skills and social awareness
- Help others with willingness and pleasure, without expecting anything in return
- Share things or possessions to help solve problems or create happiness for others
- Actively participate in activities that benefit school, community and society

The 21ˢᵗ Century Teacher

Since the expected skills and characteristics of the 21ˢᵗ century learner have changed, and technology has made knowledge more accessible and no longer teacher-centered, traditional learning management cannot meet the needs of society anymore. Hence, the 21ˢᵗ century teacher cannot just spoon-feed knowledge to learners anymore. They must be keen to develop knowledge and skills regarding their changing roles in order to prepare learners for the future.

Essential skills of the 21ˢᵗ century teacher include:

1. Facilitating - This refers to conducting learner-focused teaching by providing appropriate environment, media, equipment and advice so that learners will be able to construct knowledge and develop skills by themselves. The indicators are as follows:

- Ask questions to motivate learners to think and be eager to learn
- Manage learning based on contemporary theories of learning and teaching
- Organize learning processes focusing on learning activities that allow learners to create knowledge by themselves
- Be a good listener and pay attention to learners' thoughts
- Inspire and foster a positive learning environment
- Manage teaching and learning time effectively
- Manage the discussion by asking questions and keeping learners on track when they go off topic
- Let the learners present, and listen to their assessment results through various methods

2. *Collaborating* - This refers to offering learners an opportunity to learn from experts or specialists, and to be able to share knowledge or work with others. The indicators are as follows:

- Allow learners to complete tasks in pairs or small groups
- Support learners to work with the team to set their goals and work plans
- Encourage learners to allocate roles and responsibilities among team members
- Support learners to create workpieces with cooperation among all of the team members
- Support learners to accept each other in the team
- Support learners to learn, work and solve problems together as a team. Offer everyone a chance to express their opinions and give feedback on their workpieces

3. *Personalized learning* - This refers to teaching that is concerned with each learner's aptitudes and differences. The indicators are as follows:

- Organize child-centered learning in which learners can choose to learn according to their potential and interests
- Encourage learners to explore, search and understand new things, and integrate existing knowledge in problem solving that corresponds to the reality
- Observe learner interests and aptitudes, and provide them an opportunity to choose to do things that meet their interests
- Provide content and activities tailored to a learner's cognitive capacity to support the development to their full potential
- Be a good mentor to help extend a learner's knowledge
- Inspire and stimulate learners to be curious, and encourage them to find answers on their own

4. Authoring and publishing - This refers to creating, preparing and presenting information and content resources to learners. The indicators are as follows:

- Be curious, eager to learn, and love to pass on the knowledge to others
- Be skillful in presenting information in an easy-to-understand way
- Be able to use language that is suitable for learners
- Be able to spread information in various formats through multiple channels

5. Innovation skill - This refers to being a creator who is eager to learn and search for new teaching methods and tools to apply to learning management. The indicators are as follows:

- Present new ideas or innovations that can extend the existing knowledge
- Find new ideas or perspectives for learning management by using a variety of techniques
- Creatively develop teaching tools and methods to increase the effectiveness and efficiency of learning management
- Creatively apply and relate new knowledge to existing knowledge

Learning Space of the Future

Since the skills and characteristics of learners and teachers have changed, learning management processes and learning environments that can generate a new form of learning need to be changed accordingly. A traditional classroom, where a teacher stands in front of the class and students sit up straight to "listen", must turn into a space for "learning by doing".

The STEAM Design Process and Makerspace are a learning management process and creative learning environment model designed by the Starfish Education and applied to Starfish Maker Partnership schools in 2017. This was later expanded to other schools in the Teacher School Quality Program (TSQP) by the Equitable Education Fund (EEF), to concretely enhance the development of essential skills of the 21st century learners in Thailand.

STEAM Design Process

The STEAM Design Process is a learning activity organizing process through the Design Thinking method. It begins with a problem that leads to the solution acquired by thinking and researching. Then, learners will exchange and share ideas to plan, create, test, and improve their work. The STEAM Design Process is a tool that encourages children to develop their analytical thinking, problem solving and systematic working skills, together with social and emotional skills that play an important role in the 21st century.

5 Steps of the STEAM Design Process

STEAM DESIGN PROCESS

- ถาม • ASK
- จินตนาการ • IMAGINE
- วางแผน • PLAN
- สร้างสรรค์ • CREATE
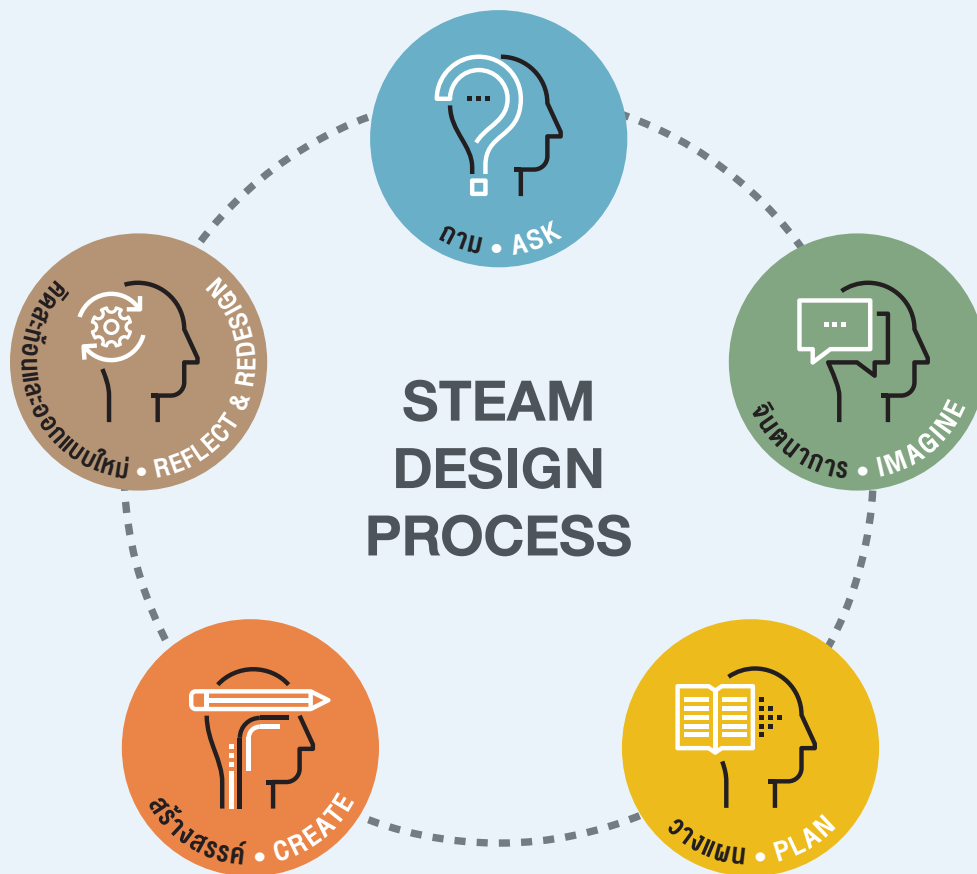- สะท้อนและออกแบบใหม่ • REFLECT & REDESIGN

Diagram of the STEAM Design Process, by Dr.Nanthaporn Janchalia Seributra

1. *Ask* - Understand and interpret problems to find the root causes through observation, interview, exploration and studying information from various sources.

2. *Imagine* - Brainstorm ideas to determine various methods, formats or approaches to solve problems.

3. *Plan* - Make a plan and a to-do list to solve problems, design the detailed work process, and create a list of needed materials and equipment.

4. *Create* - Implement the plan through various forms of creative work such as models, documentaries, books, workpieces, or creative campaign.

5. *Reflect and Redesign* - Analyze the quality of work, evaluate the working performance, and listen to other people's suggestions for further development and improvement.

The STEAM Design Process aims to promote the application of knowledge for problem solving in work and real life. It integrates knowledge from four interdisciplinary subjects in Science, Technology, Engineering, and Mathematics, also known as STEM Education. Art is also added to help develop both brain hemispheres; the left brain that works in decision making, logical thinking, analysis, sequencing, formats, language, calculation and being realistic, and the right brain that works in creative thinking, intuitive and emotional perception, imagination, artistic aesthetics, and designing.

Teacher can apply the STEAM Design Process to activities that already exist in the school such as

1. Moderate Class - More Knowledge activities
2. STEM Education
3. Project Based Learning
4. Integrated Learning

Makerspace

Makerspace learning management is meant to organize a learning environment for learners to become familiar with systematic problem-solving. It promotes learners to think, solve problems, be rational and logical, and be able to create innovation. It also fosters a creator culture through the STEAM Design Process, with the teacher as a key person to help learners develop essential skills and characteristics of the 21ˢᵗ century.

Makerspace allows its participants to create things based on their own interests and specialties. It can be organized in various forms such as a whole room, a corner in the classroom or library, or a mobile kit to be used in activities in each learning unit. A whole-room Makerspace as operated by Starfish School allows teachers to prepare equipment according to the concept of each room, such as a cooking room, an art room, a mechanic room, a sewing room, etc. These rooms can help organize project-based learning to promote and develop the 21ˢᵗ century skills.

Authentic assessment

Authentic assessment is a class-level assessment using empirical data, such as workpieces, portfolios and learning behavior observations as forms of learning evidence. This assessment can be conducted by several methods and assessors in which learners are allowed to assess their own learning outcomes, and multidimensional information is also provided so that they can use it in self-development and reach their full potential.

The key features of an authentic assessment are as follows: (Department of Curriculum and Instruction Development, 2002: 159)

1. It assesses complex thinking processes, the ability to perform tasks, and learners' potential as a producer and their production processes, rather than assessing the knowledge learners can memorize.

2. It assesses the ability of learners to analyze the areas that should be promoted and revised so that learners can develop their full potential according to personal abilities, interests, and needs.

3. It allows learners to participate in assessing their own and classmates' performances, which encourage learners to know and believe in themselves, and be able to develop their performance.

4. The data collected from the assessment must reflect how teaching plans and processes meet individual learner's abilities, interests and needs.

5. It assesses learners' abilities to transfer knowledge into everyday life.

6. It can continuously assess different aspects in different situations with various methods.

The authentic assessment is, therefore, an appropriate assessment that is in line with the STEAM Design Process learning management method.

How to do an authentic assessment

1. Observation: Assessors observe and record learner behavior during learning activities. The learning behavior observation form can be created to observe the focused topics.

2. Portfolio: Learners can select their successful works from their own practice to show their learning development during the school year. Hence, portfolio assessment needs to allow learners to freely select and present their works, with clear criteria to judge their value. It should also let learners reflect on their own learning outcome.
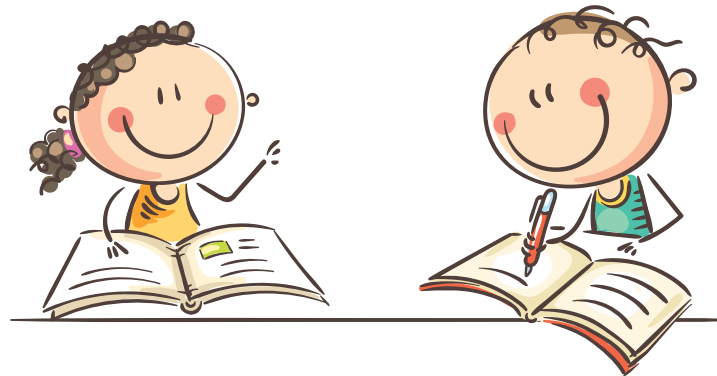
Professional Learning Community

Professional Learning Community (PLC) means the collaboration between teachers, administrators and educators for learning and exchanging visions, goals, and missions. Based on a friendly relationship, they work together and support each other to solve problems and continuously develop professional capacity. This will bring positive changes in the education system and foster learners' essential skills for the 21st century.

In conclusion, teachers in the professional learning community will eventually developt knowledge and practices as follows:

1. **Sharing among** teachers about their teaching work focusing on 4 aspects; individual teaching methods, learners, other teachers and professions. Teachers should exchange ideas, knowledge and experiences to bring development and solutions to learning management.

2. **Work collaboration** is a vital factor for building a successful professional learning community. Everyone in the organization must help and support one another and be responsible for the learners' learning outcomes. Therefore, integrating people from all school departments to take part in developing the professional learning communities is the way to sustainable success.

3. **Accountability** is the responsibility of each teacher to realize the importance of self-improvement according to the work plan, in order to exchange knowledge and experiences from their work practice with other members.

Chapter 2

STEAM Design Process:
Lessons Learned

Kids Studio

Kittikorn Kong-In *Ban Na Mon School, Chiang Mai*

Ban Na Mon School is a boarding school in Wiang Haeng district, where most of the students are from different ethnic hill tribes, and lack educational opportunities and technological access. After the school came across the STEAM Design Process from Starfish Education, a project to promote learners' skills through a creative space, known as the "Careers from the Little Hands", was started. Based on the Starfish Maker method by the Starfish Education, they have arranged a learning environment by organizing Makerspace rooms that aim to develop occupational skills according to the school's identity, and build a creator culture for children to be able to live a self-sufficient life.

Ban Na Mon School's identity is a self-sufficient school. We organized our education by focusing on occupational skills based on 6 agricultural activities: animals, fertilizers, rice, flowers, fruits and vegetables. Children would practice and adapt it to real life. However, after the Careers from the Little Hands project was initiated, now we have a basketry room, science room, art room, studio and craft room, all of which are new experiences that our children have never tried before.

3 2 1 Action!

Access to technology seems to be far from reality for children at Ban Na Mon School. Teacher Kittikorn, who realize the importance of technology in teaching and learning, has overcome this challenge by managing the studio activity and applied 5 steps of the STEAM Design Process to the learning process. This allows junior high school students to create music videos by themselves in every process.

This new result-based activity requires clear discussion about its objective and approach to make teachers and students share a common direction and goal before going through the STEAM Design Process, in which the teacher becomes a learning facilitator and learning collaboration builder.

Before starting the activity, we discussed with students about the purpose of this activity and what they are going to do. Then, we introduced them to the STEAM Design Process, and began with the first step: ASK. We let them ask themselves what they want to do and then discuss together. The students raised many topics, but we had to choose the one with the most possibilities and decided by majority vote.

After the topic has been chosen, in the second step: IMAGINE. We let students do brainstorming. Last month we decided to shoot music videos. Students proposed lots of ideas for the music video, so we had to discuss and voted for the best possible one, then considered about the items we needed to complete the task.

Teacher Kittikorn's studio still lacked some equipment, yet waiting until all required resources are fully provided would delay their work. In order to maintain the enthusiasm of junior high school students, teachers must respond to their needs promptly. Under the limitation, students can begin their projects with things they already have, with the teachers as a learning collaboration builder who encourages students to collaborate and share their work responsibilities. This will let students learn to work and solve problems together, which helps them finish their projects in the Makerspace studio. It also develops team collaboration skills and leadership, which are some of the essential skills for the 21st century learners.

Then, we went on to the third step: PLAN. The equipment that most students at Ban Na Mon School have are phone cameras, but they aren't allowed to use those at school. So, they used the teacher's camera instead. We also bought a green screen to make a changeable background and some microphones and lights. These are all equipment that we could afford.

Is this enough ? No. it's not. Students told me they needed costumes and much more. They discussed how they could get all of the stuff and who would bring the items. So, they planned who was going to prepare which equipment and material.

For the performance, they also planned who would be the main characters, supporting roles, director or light controllers. There were 14 students divided into two groups. They managed to share responsibilities by themselves with some advice from the teacher. I prepared some items for them, but they had to prepare some as well.

The joy of working together is a key factor that teachers must try to keep. Even if there are mistakes, it is a part of learning. Teacher Kittakorn set up an atmosphere for this learning process to encourage opinion exchange among all groups in order to develop the students' relationship skills, which are abilities to understand perspectives, emotions and feelings of other people, using proper language to communicate one's own thoughts, and build working collaboration with others. Most importantly, this open exchange of critical commentary will later lead to the improvement of their products and work processes.

In the fourth step: CREATE, the working atmosphere was very fun. When they actually did their work, there were some mistakes or bloopers, but it was all about learning. Initially, students were shy because it was a new thing they had never done before. It was normal to hit a few bumps in the road. Actually, they had already planned everything and just followed the plan, which turned out very well.

After finishing their works, we screened and watched the work of each group together. Everybody would analyze and criticize the results of their work. Had they done it well enough? Was there anything they should improve ? For instance, we found that the latest work had a problem with the background where green shadows appeared. Even when they replaced the background, there was still some noticeable shadow, which wasn't satisfactory. There were also mistakes when the actors weren't on cue. So, they had to discuss how to improve it and came up with a better idea.The opinion sharing was not only occurring in the group, since the final work would be shown to all groups of students so that everybody could give their feedback.

I gave students the freedom to express both positive and negative opinions. When friends suggested the points that should be improved, a group would revise their work plan. Normally, they listen and accept friends' suggestions because it could actually make their work better.

During each stage of the STEAM Design Process, students are encouraged to harness their skills and potential in many different ways, which may be difficult or challenging for each student. The teacher organizing these activities must provide indirect guidance to let students think freely and be creative within the framework.

Every step of the STEAM Design Process is important. The final step: REFLECT & REDESIGN, is a process that will help students develop their work to reach the highest quality and can be collected in their portfolios, in which the students will be proud of themselves for being a creator.

Planning in the third stage is also a critical point. Students need to carefully plan the tools and materials they need and list out all. Each team member's responsibilities must be clearly stated. They also must plan a sequence of what they are going to do at this stage. In fact, I must say that every step is important, even for the first step of asking questions. If we don't get the topic that students are truly interested in, the result may not be successful.

From my experience, after the students raised questions and agreed with the chosen topic, the reflection in the last step always tells how their work can be done better. The STEAM Design Process is an excellent method for student development because after trying the first time, the next time students have to think and come up with a better plan to do better work.

Speaking English in front of a camera

The students at Ban Na Mon School can be grouped into 2 major tribes: Karen and Lisu. Thus, a big problem for students here is communication as they communicate in their own dialects, and sometimes even Lisu and Karen students cannot understand each other. This becomes a challenge for teachers in grade 1 to teach students to understand the Thai language before learning academic subjects.

Therefore, it is a bit chaotic for Teacher Kittikorn, who primarily teaches English, to teach this group of students speaking Thai as a second language to learn English as their third language.

Sometimes, I have to translate from English to Thai and back to their native language again, to help them understand the vocabulary better. This means I need to learn their languages as well.

With his expertise in organizing studio activities, Teacher Kittikorn has designed activities to help ethnic minority students to memorize new English vocabulary with happiness and fun by integrating English subjects with the video shooting activity.

Based on the STEAM Design Process, the teacher begins by asking questions about what they would like to do in the studio. Teacher's questions induces students to think about integrative activities aiming to learn English vocabulary through educational materials they made by themselves. Students are guided through to the last step: REFLECT & REDESIGN, where Teacher Kittikorn created a positive atmosphere for grade 1 students' learning exchanges, which was useful for their planning on further improvements.

Normally, our studio room is used by middle and high school students for learning to shoot videos, but we've decided that elementary school students can use it as well. I let them express themselves through acting in the teaching media. According to the STEAM Design Process, I asked them what they want to do in a Makerspace studio. They had different ideas, but what they wanted to do and also related to what they were studying was the English teaching media about vehicles. Then I asked what would we do to get teaching media about vehicles to be made in our studio. Some students could answer, some couldn't. In the end, we chose to make a video that everyone participated as an actor and spoke different vocabulary.

At the third step: PLAN, we talked about the equipment that students would use. I provided some equipment and we didn't need anything more. Then, students figured out their favorite vocabulary, like car, plane, train, etc., and prepared to speak their chosen word. I had to check whether they chose the same word or not until it was perfect for everyone.

Then we talked about how to make our work run smoothly when students had to go in front of a green screen one by one. Those who were not on cue had to sit down and wait without making loud noise. They must wait in line and prepare themselves. During the shooting process, after I finished setting a camera, students had a chance to practice speaking one by one. The first one walked into the frame and said "plane", the second one "bus", the third one "bicycle", and so on. They rehearsed until I saw they were fine, and then we started shooting. After finished the shooting, I had to do the editing part because they were too young to do it.

In the end, we watched the final work together. They were very happy to see themselves on TV and laughed. Whoever spoke on the screen, they were all laughing. This was a new experience for them.

When I asked if this work was good enough, they said there was someone speaking in a low voice or not clearly. So, next time, would it be possible to speak louder, clearer and rehearse more to get it right ? Students said they could. This was a plan they would continue to do in the future.

The learning outcome of the learners

For both the music video shooting activity in the "Career from the Little Hands" project and the English learning media making for young students, in the end the perfection of their final work is considerably less important than skills and characteristics they have learned and developed from each activity. The success of the STEAM Design Process in Ban Na Mon School's studio room has been clearly reflected through the students' changed behaviors.

Previously, I've noticed that students at Ban Na Mon School were not very assertive. They were too shy to do what they wanted to do. Since I've become a teacher here, I've tried to develop their assertiveness because English learning does require speaking. This project allows students to be more assertive. In a studio room, they can be an actor, share duties and practice better teamwork. They can plan and work in steps by using this process. Actually, it's like what we've been doing, but more systematic. The STEAM Design Process provides us a clearer pattern that children can follow through on the entire process.

They not only raise the students' assertiveness, but activities in Teacher Kittikorn's little studio also allow a group of students with weak academic potential to become "smart kids" in their own way.

This is the concept of transforming a teacher's role into a personalized learning developer who manages learning by observing aptitude and differences of individual learners and let them choose to do what they are interested in or good at.

Middle and high school students attending studio activities are mostly weak in academics, yet they really enjoy the activities. Even though they're weak at academics, they do a pretty good job here. They may not be able to compete with friends at studying. Their skills at mathematics, Thai or English may be at the bottom of the rank, but their practice and assertiveness are among the top.

The teacher learns with students

To organize a Makerspace based on occupational skills training, the teacher is not required to be an expert in those occupations, yet can learn more professional skills related to a particular occupation to be able to assist students in their work.

Teachers should, therefore, not only be an innovator who creates and searches for new methods and tools to apply in the teaching, but should also discuss with fellow teachers about creating a professional learning community for exchanging knowledge, solutions, as well as developing learning management, without concerning the differences of subject groups as an obstacle to reaching the goal of developing students and creating a shared learning environment for teachers.

There are 2 advisory teachers in a studio room, myself and a computer teacher. We always talk about what more we can do to develop our students. How can we solve problems ? Can we find another software ? Can we find a light or a shooting box to help students practice more ? There are things that we still don't know or something that students want, but we don't know what it is. In this case we will honestly tell them that we didn't graduate from the computer field. I mostly find additional knowledge on the Internet. There are videos on Youtube and training courses on Starfish Labz. I also trained with external agencies because I quite like technology. I like to learn as well.

I actually teach English, but now I'm also responsible for IT work, video, and photography. It's something I've loved before I was here. They saw my potential and let me do it. I have to continue to learn more and more because the world doesn't stop, right ? It's been developing every day, so we need to develop ourselves too.

In the future, Ban Na Mon School's studio room will be continuously packed with students taking turns to do a lot of fun activities. Furthermore, Teacher Kittikorn has also planned to develop the "Career from the Little Hands" activity to focus more on the community by letting students practice advertising photography with unique local handicraft products, hoping that students' work will increase sales and generate income for the community they grew up in.

When career opportunities are created, the identity of Ban Na Mon School has come to fruition, which is to be a self-reliant school and benefit the community as well.

Thidarat Ruentoom, 9th Grade

My dream teacher is like Ban Na Mon teachers because they're nice, good at teaching and always offer consultation. What I like most about learning this way is that I can learn with friends, we can discuss and work in a team. The STEAM Design Process helps us be organized and work step-by-step. When we make mistake, we know how to fix it. A green screen problem, for instance, if the light is unstable, a green screen will be noticeable in editing process. So, our solution is about light control, and we have to make it stable next time.

Khwanta Latan, 9th Grade

I love being an actor. It helps me practice assertiveness and increases my confidence. But the difficult thing is editing; I don't know how to use a computer program yet. Talking about the dream teacher, I like a teacher who understands and reaches out to students, and who is good at counseling.

Khwanjira Yeun-yongphongkiri, 9th Grade

I like teacher who listens to our problems and reasons, and who helps us solve problems together. I like being a director because I can organize the character cues. I can know the actors' roles and direct their performance. But I've got a problem when shooting frame is too wide causing an unwanted background in the image. The solution is to set the camera steady to perfectly frame the background.

STEAM with Arts Education

Monchaya Hinseesuwan
Wat Rong Or School, Chiang Mai

STEAM is quite similar to STEM, which is integrated learning based on science and math. So, when many schools start to implement the STEAM Design Process, they usually believe that it is easiest to begin with science-math subjects or activities. In fact, the STEAM Design Process is a learning process that encourages students to think and practice in every subject field. One example is from Teacher Mon from Wat Rong Or School who has applied the STEAM Design Process to Thai language subject and Thai dance activity, and achieved remarkable success.

After attending a study tour at Starfish School, we applied what we had learned to our Moderate Class - More Knowledge session, 2 hours a week, into 8 activities: Folk Music, Thai Dance Movements, Little Scientists, Math Playground, Reading is Life, Healthy Food, Fun Farm, and Sing - Dance - Draw. We also applied to the main academic subjects, including Thai language. Science teachers applied the science subject and the Little Scientists activity as well. Teachers who taught technology and vocational subjects also applied it to their additional subjects. There are about 4 - 5 teachers who pioneered in applying the STEAM Design Process to their subjects.

Thai Dance Movements

Among 8 Makerspace activities at Wat Rong Or school, Teacher Mon is in charge of the Thai Dance Movements activity. The STEAM Design Process is used to guide students in designing their performances, with a goal of taking these amateur dancers to the stage in local festivals.

I've tried using the 5 steps of the STEAM Design Process. The first step is to ask. When I asked students a question, they would imagine how to achieve the goal from this question. For example, in a Thai Dance Movements activity, my question was that our municipality had been holding festivals every year, so how would we plan to join them with our show ? After I raised this question, students imagined what kind of performance they would prepare. When I asked about the reason, they said it had to be appropriate for the occasion and event. After they finished their imagining process, they planned on how to learn more about the dance and achieve the expected results. Then, they separated into small teams to research different types of media. One team searched in books, one team searched on YouTube, while another team came to study with me. Once they finished planning and studying, all of them came together to finalize how they would do or adjust it, and planned their work by drawing dance gestures on paper.

Work analysis and evaluation are not only undertaken in the final step of the STEAM Design Process, but along the journey to reach the goal, students will analyze and evaluate together. This means everyone in the team is learning and growing together by sharing thoughts and getting inspiration from each other. The teacher is a Makerspace expert who provides students with strong support and the opportunity to practice design thinking. This way, students' learning behavior will change from being a passive learner to be more enthusiastic in creating something by themselves, which helps them obtain more accurate knowledge.

If it was a song with lyrics, they would practice singing first from YouTube and later sang to me. Then, they designed movements and discussed in a group if they were appropriate or beautiful enough. I gave comments on how the movements suited the lyrics or the show. Then, they planned out the practice. After they finished practicing in all parts, they put them together and rehearsed with the lyrics.

Then, they would plan costumes that were suitable for their show. What they loved the most was when they could think and do by themselves. This way, they could remember well. I didn't have to repeat much, just advised them to be right on track.

Problem-solving skills

Wat Rong Or School has done Makerspace activities without a dedicated Makerspace room. Despite the limited facility, it is not an obstacle that ceases Teacher Mon from teaching.

Teacher Mon has solved this problem by transforming the Makerspace concept into a mobile learning kit, and use a wide space for some activities that require movements and loud noise. From Teacher Mon's perspective, any space can facilitate the essential skills development for students' future.

There is no room available, so we use a meeting room. For each class, we have to put various tools and equipment, including colored pencils, paper and tools, into a cart and move in. After class is over, we pack things up again because we don't have a specific room. We have a few buildings. When students perform in public, sometimes they receive money. I will ask them to keep this money for buying clothes and accessories.

Even though the context of learning management is not perfect, when teachers and students solve problems together by using applied thinking, the limitation can become an important part in fostering the essential 21st century skills for students which can be applied to every situation they encounter both in school and daily life.

In order to encourage the learning practice, Teacher Mon decided to watch from a distance and patiently wait for the students to express their ideas, solve problems and discover answers by themselves. This aligns with the principle of Jean Piaget, a psychologist known for his theory of cognitive development, who said, "When you teach a child something, you take away forever his chance of discovering it for himself." However, Teacher Mon is always available to support and ask reflective questions to stimulate their thoughts on how their work can be improved.

The skills they will develop are critical thinking, problem-solving, team collaboration, and life skills that they gain from working together. They will solve problems together and know how to seek help from others. Their solutions may be childish, but we have to watch from a distance and provide the support they need.

They've performed several times and been invited from the municipality every year since to perform in municipal events and fairs, temple fairs, Loi Krathong festival, New Year's festival, and Poi Luang festival. Were they satisfied with their past performance ? Yes, they were. After each show, they would reflect on what should be improved. Sometimes they were too excited and had made some mistakes, but when they performed more often, they got better. I asked them how to fix this problem, and they said they need to practice more often until they could remember all of the movements.

STEAM Design Process for the Thai language subject

How can Thai language teaching let students practice system thinking ? Although the STEAM Design Process is a principle of scientific thinking process, its execution is not limited to only experimentation or invention. Teacher Mon, who is mainly responsible for teaching Thai for 5th and 6th grade students, has applied the STEAM Design Process to her Thai teaching by going through the 5 steps and reflecting on learning with students until they construct their knowledge. The Thai language subject used to be boring and focused on memorizing, but has now turned into the subject that every student wants to learn.

When students plan on developing academic achievement by themselves, the teacher has to play a role as a learning facilitator by giving appropriate advice for knowledge building and skills development. Teacher Mon's application of the STEAM Design Process in Thai teaching during the Moderate Class - More Knowledge activity is, therefore, a good example of reducing the "spoon-feeding" as a traditional lecturer and turning into a facilitator who promotes learning, asks challenging questions, and encourages learners to learn happily by themselves through hands-on practice. This also increases opportunity for learners to construct their own learning.

There are pre-tests in each unit of Thai lessons. I will announce the test result and let students ask about the part they don't understand or can't do. When I ask who gets a full score, nobody does. Everyone makes mistakes on tests. So, I ask what they should do to get full score. This urges them to use the IMAGINE process to figure out how, such as further studying or researching, and then to write their plan. When I teach reading comprehension, for instance, they may ask to spend 2 hours for doing research.

I sometimes use the DLIT media of OBEC or suggest students to do further studying and access various technologies in a computer room. Sometimes if computers are not enough, they can read books instead. If it's boring, they can talk with me and I will provide them with information. After completing the study of each unit, everyone will retake the test. This time their scores should be higher, but will they all get 20 scores ? No, they won't. They will have some 2 - 3 missed points. So, to fix these missed scores, they have to study more about it. The reflective thinking can occur this way.

For example, if they don't understand the syllables and words unit, they need to research more and retake the test until they're satisfied with their test result. Each student has different abilities and talents. The patient one may want to achieve 20 scores, while the one having less patience may be satisfied with only 16 - 17 scores. It's up to them. Every time, no matter what topic we study, we will use this process to help students think systematically. It's a pretty good process.

Teacher Mon always tries to ask questions that relate to problem-solving in real life to make this learning meaningful for students. Teacher Mon never tells students what to do, but encourages them to look at the destination they want to go to, and let them figure out how to reach the destination by themselves. This way of teaching requires lots of time and patience. However, when the children construct knowledge by themselves, it will strongly stick in their brain and will not fade away easily like that from rote learning.

When teaching about letter writing, I will ask students if their sick leave letters were already correctly written and used proper language or not. They altogether say that they can't write by learning just one or two times. The pattern is wrong. The heading and the ending are also wrong. So, how should they do to make it right ? They will plan and do self-study. Then, I will ask them what the solution is. Their answer is that they need to practice several times until they can remember and write it correctly. Finally, their work will be improved. I also got a feedback from the advisor teacher that now their sick leave letters are correct, unlike previous ones that they put other names, even their father's name in the ending.

Noticeable changes in students

Most schools in northern Thailand participating in the School Transformation program have many students from ethnic groups, causing teachers to deal with several constraints in terms of language and learner readiness.

Nonetheless, the STEAM Design Process for active learning that focuses on thinking process and hands-on activities has helped these students overcome limitations, and they have developed their skills into their strengths. This has been reflected through the noticeable changes within them.

80 percent of our students are Tai Yai. They have trouble with Thai language because their speaking tones will distort the tone marks in their writing. Their parents are also unable to read or write. Most of them are poor and do daily labor work, so they can't take care of their children. Some of them stay in construction camps and don't have TV, so their children can't do distance learning. Therefore, these children have to mostly learn from teachers at school.

Our students may have trouble with writing, but their ideas are great. They're creative and eager to learn. Their good point is diligence in studying. Some may be lazy, but most of them love to learn, especially in the Makerspace where they can learn by doing. They really enjoy classes like farming, folk music, Thai dance and healthy food, because these activities don't require writing. Children love learning by doing.

It is not easy to change students' mindset from being passively educated in the traditional learning method to practicing system thinking to create works by themselves.

Even though Teacher Mon's Thai language and Thai Dance Movements activities are not science-math based, the STEAM Design Process helps foster system thinking into the students, resulting in the improvement of their social behavior and desirable characteristics. Their self-management in responsibilities and relationships has also been developed. They understand other people's perspectives, emotions and feelings, be able to use language to express their feelings and thoughts, and build collaboration in working with others happily.

STEAM Design Process makes an impact on their thinking systems. Their behavior is also good. Their works are well organized. They have more responsibility because they need to set time frames. If they need to finish their work within 2 days, it must be completed within 2 days. It instills responsibility in them.

Students feel brave enough to think, answer and reflect their thoughts. During the final presentation, they listen to each other's comments on what should be improved or adjusted. At first, girls and boys would fight and didn't listen to each other. They thought it was like 'if you teased me, I would tease you back.' I had to explain that it's not teasing, but an acknowledgment of our flaws. Friends are the mirror reflecting that to us. In the end, they accepted each other. No one was upset.

The challenge of conducting Makerspace is to motivate children to learn and make every learning meaningful. Teacher Mon, as an advisory teacher, has made her Makerspace a safe space for students to be themselves and feel accepted. Providing opportunities and positive communication will motivate ordinary children to be ready to change and become a creative maker in society.

The unruly children have changed. They always ask when it will be my class again. They want to participate in my class. They want to draw, paint, and design things. They love this kind of learning. These little words can cheer me up. Sometimes I ask them to think about what they can do with the leftover crafts we have. They can use their imagination and design it out. One learning hour can become meaningful to them because they like it.

The 21st century teacher

In order to push students forward, teachers must keep up with the world. From Teacher Mon's point of view, a significant factor for being a good teacher of the 21st century is to keep improving personal development.

This is the transformation of teacher's role to become an innovator and creator who is keen to learn, and to find new teaching methods and tools to apply to their teaching and learning. Teachers need to develop themselves to be able to discover new ideas or perspectives, and use various techniques in their learning management. Creativity is also required to develop teaching tools and methods systematically. Nevertheless, one of the principles of designing learning activities according to an integrated approach is to focus on the learners' happiness.

Teaching always requires new techniques. If we don't have different techniques, children will not be interested. We must think all the time. If they're bored, the teaching technique must be changed to become more exciting. Hands-on activities are always the best, so that learning hours will be meaningful and memorable. Most importantly, the learning process must be undertaken step-by-step. If the teaching is disorganized and doesn't have a final goal, children won't be able to set their goal. Before we teach, it's important to let them know the learning goal or what skills they will gain by the end of the class. Then, we teach from step one. If we don't design our teaching as a process, it will be confusing, and children will be confused by our teaching.

Therefore, teachers should keep learning, be innovative, be able to design new teaching methods, understand children and their learning styles, and know what kind of learning they need. As a teacher, we need to do additional study. I've also taken some online lessons and training courses. Recently, a lot of online courses are available like Starfish Labz. We have to be like a student, so we can keep up with them. The key point is to keep learning and searching for new things in order to successfully drive the learning transformation.

Students' voices from Wat Rong Or School

Monla, 6th Grade

The teacher I like should be able to give advice, support, and warn me when I'm wrong. At first, in Teacher Monchaya's dance class, we learned performing arts from the teacher's demonstrations, one song after another. Then we studied various dance moves from the teacher and videos. However, when the teacher adapted the STEAM Design Process into teaching, we started to think, exchange ideas with each other, and choose to learn the performances that we like. What I like very much is that we've practiced a thinking process and actually put it into action. But the hardest thing is the IMAGINE

step. Sometimes we imagined the costumes, but they were practically impossible to be made. I think that the STEAM Design Process can be applied to any activity like growing vegetables, raising animals, cooking, or inventing things.

Ampha, 5ᵗʰ Grade

Since I learned by using the STEAM Design Process, I've been able to think analytically and creatively. What I like is planning and implementing the plan, as well as reflecting to improve our works and accepting each other's opinions.

Nongnutch, 5ᵗʰ Grade

The old teaching method was fine, but the STEAM Design Process is much better because I can do what I want to do. I like planning and implementing the plan. We can reflect on each other and practice working in a team. The difficult thing for me is designing because I lack experience.

Kuljira, 4ᵗʰ Grade

The difference is that the STEAM Design Process lets us work in a team and make workpieces together by ourselves. What I like the most is that I can learn the things I want or what I've planned. But designing is hard because I don't have much experience. I will pass this learning process on to younger students.

Thinking Process in Kindergarten

Wanpisa Pruksama

Ban Pa Meud School, Chiang Mai

What is the best age to practice thinking processes ?

At Ban Pa Meud School, they begin from kindergarten.

A Kindergarten child's brain is growing rapidly. Establishing the thinking process through language learning and creative expression can help children adapt themselves and gain self-confidence. However, it is not easy to manage teaching and learning methods for kindergarten classes, since it has to integrate various content and skills that suit the learner's age. It should also focus on building the learning environment through playing and activities that promote children's potential in order to prepare them for life in the 21st century.

In the beginning, the teacher should introduce all of the working steps. We might start with an open-ended question that allows them to use their creativity. Then, let them draw a picture according to an assigned topic. For instance, in a learning unit called "I Can Do It", I wanted them to design a toy they could play with. It had to be useful and made from waste materials in our classroom. Children would walk to the Makerspace corner where there were baskets, paper boxes, colored paper and yarn, and decided what they could do with these things. Then, they would draw pictures from their imagination such as a doll, a racing car, a sedan car, a gun or a robot, and went on to the planning process.

Teacher Pim uses a 5-step worksheet to help children think and implement the STEAM Design Process. Even if they are not ready to write and spell, writing is not a barrier for kindergarten children when the teacher can provide support and assistance to develop their thinking skills accordingly.

The worksheet is the STEAM Design Process workflow with blank spaces for their answers in each step. Sometimes, I write on a blackboard for them to copy after me. In the IMAGINE step, they draw a picture by themselves. Next, in the PLAN step, they draw the materials and tools they need. Then they create their work at the Makerspace corner, and after finishing we will reflect on their work through interviewing. After that, I will write the reflection and let them copy after me.

Teacher Pim uses the whole language approach to enhance all 4 language skills: listening, speaking, reading and writing, with the thinking process as its core. Even though children at this age cannot read or write yet, Teacher Pim can provide a learning environment that helps children learn language meaningfully and align with their learning goals. Ultimately, this process does not only foster thinking and planning skills but builds up language skills for children as well.
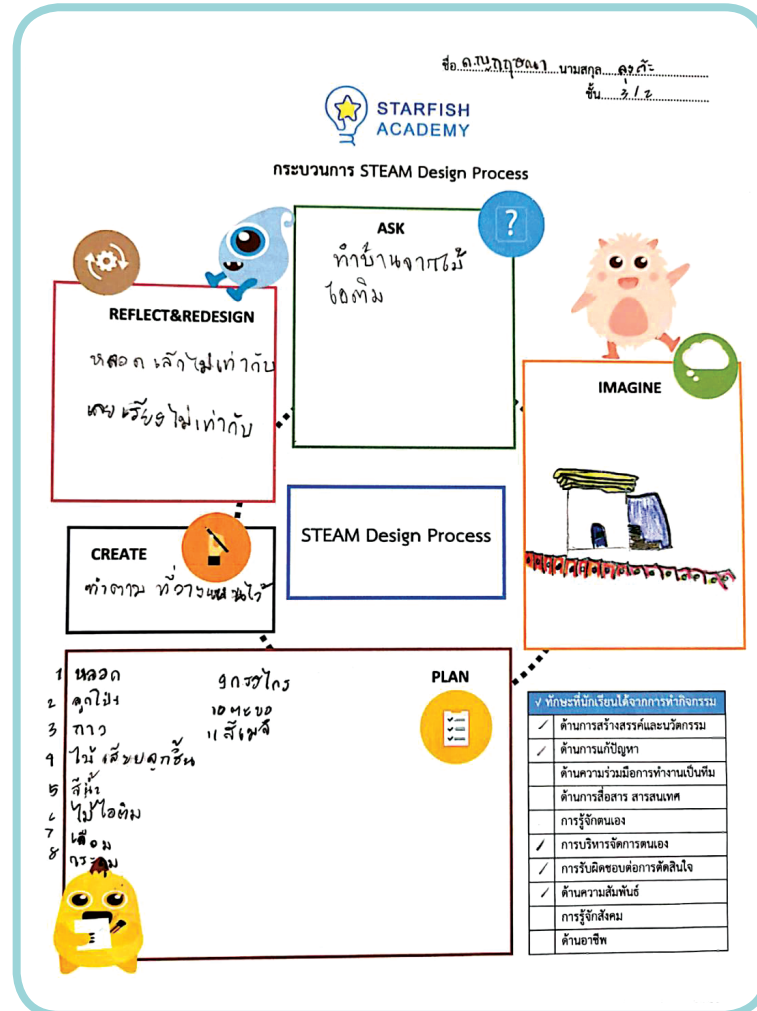
Kindergarten children still cannot write, but I try to encourage them to write. At the Makerspace corner, there are pictures and vocabulary describing each material and tool. When planning their work, they can copy the words of their chosen materials and tools into the worksheet. If they want something we don't have in the room, we try not to buy more. Instead, I will ask if they can bring unused things from their house. Some children say that they have old clothes. Someone's mom is a waste collector, so they have many plastic bottles or cardboard boxes. They have to write up and bring those materials to school on the next day.

Nurturing Creativity

According to the psychological theories of development, kindergarten is the age of great creativity development. Each child has a limitless and infinite imagination. As they grow up, their spectacular creativity will gradually be shaped into the real world by all constraints and paradigms. This is challenging for Teacher Pim, who focuses on fostering a child's imagination, to use questions to guide children into the thinking process without unnecessary limitations, and to nurture children's creativity along with logical thinking skills development.

The most difficult step is the ASK. Sometimes I try to ask open-ended questions, but I'm not sure if my questions are too difficult for children or not. For example, I asked "We have this kind of waste material, what can you create out of it?" I'm not sure at what level the children can understand. I'm concerned that I'm going to intercept their imagination. I'm a bit worried at this step. But if we can get through it, the learning will flow to the end of the process at the stage of reflection.

Teacher Pim plays a role of a personalized learning developer who questions to inspire, stimulate curiosity, and encourage learners to find answers on their own. As the Makerspace advisory teacher, Teacher Pim has used examples to spark learners' ideas as they are just getting started with the STEAM Design Process.

After finishing their works, I will let them present in front of the class, and I will keep asking questions to promote their thinking process skills. I tried to ask them if they had any problems. My questions were, for instance, "If the colored paper fell off, could you use something else instead?" "If we didn't have materials like this, could we use something else instead ?" When they worked on their pieces and encountered a problem, they would then develop problem-solving skills. For example, they used latex glue to attach yarn, but it didn't stick. They said next time they should use a glue gun instead. Well, they could tell

that the material wasn't durable at all, and should try another way next time. When they were facing the problem, they could analyze it. However, it might take time because the first semester was quite a problem. Students' thinking process skills and creativity were still limited. I tried to keep them motivated by showing creative YouTube video. For instance, if they knead the play dough and mold it like in this video clip, it can become like this. I would say something like this to inspire them.

After students finished their work, the final products may not always be successful. Each student's viewpoint on their own work depends on how teacher conducts the reflecting process. Teacher Pim uses a feedback method with positive reinforcement by attentively listening to children's thoughts in order to encourage them to confidently express their views, feelings and actions, and have the courage to develop their work or start creating a new one.

I won't say it's wrong or that it doesn't look nice. I will support them and tell them that they have done very well and try to let them reflect on the problem, so they can improve it next time. I try to give positive reinforcement. If I said something like, "What is that ?" "What did you do ?" "I can't figure out what it is.", they would feel their work wasn't nice, and next time they wouldn't want to do it. If we can't really figure it out, it's better to ask them, "What is this ?" and when they tell you, you can say, "Ah, I see. I've never seen it before. It's so cute!" "Why did you make this ?" "What can it be used for ?" "Very good! Your parents will love it. You can bring it home and show to your family." This way, they will try to tell us about their work. After they brought it back home, they always come to tell me how it is in their house. They feel more valued and appreciated on what they've done. Their self-esteem has also improved.

All things are difficult before they are easy

There have been many times when the teaching reform programs increase workload rather than assisting teachers. Using the STEAM Design Process with kindergarten children may also require some time for adaptation, but once the teacher and students have mutual understanding about its process, student cooperation will systematically occur and the teacher does not have to force students to participate in learning.

Additionally, the integrated learning management and the Makerspace corner provide children with opportunities to practice thinking and self-reliance skills, which reduce the teaching time and teacher's workload, as well as equip children with process skill and more content.

We have to work hard at first, and it will be easier later. At the beginning of new semester, they didn't know my teaching style yet or how to use each corner in the classroom, so it was a bit difficult. But when we introduced them, once they learned the process, they would be able to automatically go on. It turned out that the work wasn't as hard as we thought. It becomes a cycle for them. I just put the STEAM Design Process worksheet in

a basket. When I tell them to do activity, they will pick it up from this basket, write their name and draw pictures by themselves. If there's any word they can't write, or if they can't find vocab in the Makerspace corner, they will ask me for help. They do this every time, so it becomes an automatic behavior. I think this process meets the children's need. It can also integrate with all subjects, so the teacher isn't tired.

One of the factors to drive school administration in the whole school reform is the community. Seeking cooperation from parents is the most concrete way to create each student's development. At the same time, parents can also take part in building the Makerspace and follow their children's progress from the teacher's reflection.

It isn't a burden; it turns out to be fun when the learning is always evolving and not boring. Children's work is being created all the time. In Makerspace, we just have to fill in used up items, and sometimes let children and parents to get involved. If parents have paper boxes or plastic bottles, they can share with the Makerspace corner for children to create their works. This way, the space is not only the teacher's responsibility. It turns out to be a co-creation between parents and their children as well.

The key technique that allows children to demonstrate their potential and develop the learner's skills of the 21st century is to stimulate their learning interest through questioning and patiently wait for the child's thinking process to develop. When teachers adjust their role to become a learning facilitator, and increase time for children to learn about things that are really meaningful to them, the early exhaustion of implementing the STEAM Design Process will eventually gain satisfactory results.

Old-school teachers always want children to answer, but they don't want to wait. They might ask, for example, "What is this picture ?" Students don't answer yet, but the teacher will say suddenly, "Oh! It's a fish." The teacher doesn't try to listen or ask stimulating questions. They just answer for students. It's like blocking children's opinions and expressions. I feel that they are too intense in playing a role of the teacher. If we change from being teacher-centric to become a coach or a facilitator who guide children on what they really want to learn, I think we can bring out their potential and the 21st- century skills. We'd better adapt ourselves to the modern learners.

The Little Assistant

It would be like herding cats to organize an activity that young children can use the equipment safely. Especially when there is a language barrier which makes the teacher and children cannot fully understand each other, classroom management would be quite chaotic.

Peer support is another way that Teacher Pim has kept the Makerspace activities running smoothly, by selecting students who are creative, are able to communicate in ethnic languages, and have a better knowledge of resources and tools available in Makerspace to be assistant coaches and help guide their friends on behalf of the teacher.

At the beginning of new semester, they worked in groups first. I tried looking for the one who could be my assistant coach. Since I taught alone in the class with 20 children, I had to find another promising child to help their friends. After completing group activities, I let them work in pairs and finally do their solo work.

The assistant coach will guide and help friends. I have to admit that some students may lack creativity. Approximately 80 percent of the students at Ban Pa Meud School are Tai Yai, some of whom have recently crossed from Myanmar and still can't learn Thai, not to mention low levels of creativity because most of them hadn't attended school before. So, most of the assistant coaches can communicate in Tai Yai, be quite creative, know how to use the tools safely, and be able to give their friends advice on how to do the work or which item should be used.

These little coaches not only help teachers take care of kindergarten friends but also the elementary students who are interested in Makerspace activities. The interesting result is that children who are assistant coaches gained more expertise in the STEAM Design Process by converting their roles from a learner to advisor.

When the elementary students come to pick up their siblings in the evening, they see that some kindergarten kids haven't returned home yet. For some kids, if their work hasn't been done, I let them finish it after school. Elementary students seeing the Makerspace are also interested in creating something, so I let my little coach assist them. It turns out that kindergarten students can be a coach for senior students. They will ask their seniors what they want to create, then let them think and draw in the IMAGINE part. This means they can explain the STEAM Design Process to the elementary students. In the last semester, we've expanded this method to many elementary students. Almost 10 elementary students came to my classroom after school, until it became a problem since I was the only teacher there, and had to teach from morning until 5 p.m. So, I had to designate the date and time and the maximum number of students in our Makerspace corner.

Previously, elementary students had their own Makerspace but didn't have a certain room yet. So, it was integrated into the club activities every Wednesday afternoon instead. This way, they could only do activities related to their club. If they were in a food club, for instance, they could only do the cooking. But when they came to my classroom, they could do anything they want. If a boy wanted to create a necklace or a crown, he could create his works without any limitation.

Inspiration of the Little Maker

The essence of Makerspace education is to encourage children to have freedom of thought and learn by doing. The key is that learning must initiate from the child, not the teacher, and the teacher's role should be as Seymour Papert, who defined the theory of constructivism, said: "The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge."

Organizing the STEAM Design Process through Makerspace has made a significant change to the kindergarten children at Ban Pa Meud School. These results have been reflected through their creative works and new creations they willingly developed without having to wait for the teacher to assign.

I saw a lot of changes in many students. In the past, teacher had to directly dispense knowledge or tell exactly what to do. For example, I would tell them to make a sheep from cotton wool by using all the equipment I had prepared for them. Now, since I've integrated it into the learning units' activities, they can figure out what they want to do and use their imagination. I feel that their thinking process has been developed, and their creativity has also been improved a lot. Instead of waiting for the teacher to assign something, they're now free to create on their own.

Makerspace may be just a tiny space, but it can motivate learning more than the classroom can. This space prepares children with thinking and problem-solving skills through challenging questions, and guides them in deciding to do things that are appropriate for themselves and related to real life. One example of the student's transformation that has taken place outside the school reflects that if the teacher arms them with thinking skills, whether in the classroom, at home, or anywhere, they will be able to create works that not only look good but also benefit themselves and people around them.

An outstanding work was from a student who had many pencils in his schoolbag but didn't have a pencil case. He told me that he really wanted to make a pencil case because the pencils left his bag with stains and scratches. That day, we had a learning unit, "I Can Do It", so he made a robot shaped pencil case out of a carton box. He's been using it up until today. During a home visit, his mother told me that her son still uses this pencil case. Whenever he found unused items at home, he would turn them into inventions. The mother was a bit surprised when her son suddenly became an inventor and asked her to buy a glue gun. I'm so happy that he can at least turn something worthless into a creation that can be used in his daily life.

From STEAM to STAMPER Learning

One of the most important skills for learners in the 21st century is modern communication: Communications, Information and Media literacy, which is the ability to communicate with languages, convey ideas via media, and prepare a presentation.

After the STEAM Design Process has been successfully applied to Makerspace activities, Teacher Pim noticed the potential to further develop into a new set of learning innovations that will build learning skills and communication skills for kindergarten students.
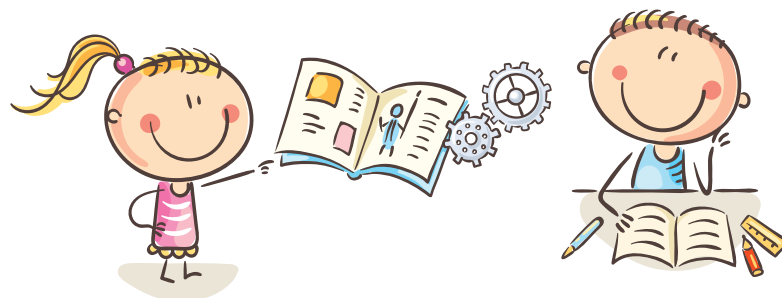
I'm now working on my own innovation developed from the STEAM Design Process, and it will be on trial this semester. This is called the STAMPER Learning innovation. It integrates various subjects, including Science, Technology, Art, Math, Presenting, Engineering, and Response, which is about listening to others' opinions. I think the children can now understand the process but still lack communication skills, especially Ban Pa Meud students who mostly lack language and presentation skills. So, I'm trying to build this innovation to develop children in this aspect.

STAMPER Learning Diagram

Quality assessment

Study principles, theories and research related to the teaching and learning process in the early childhood level

Revise and improve

Design teaching and learning process through the STAMPER Learning

Test
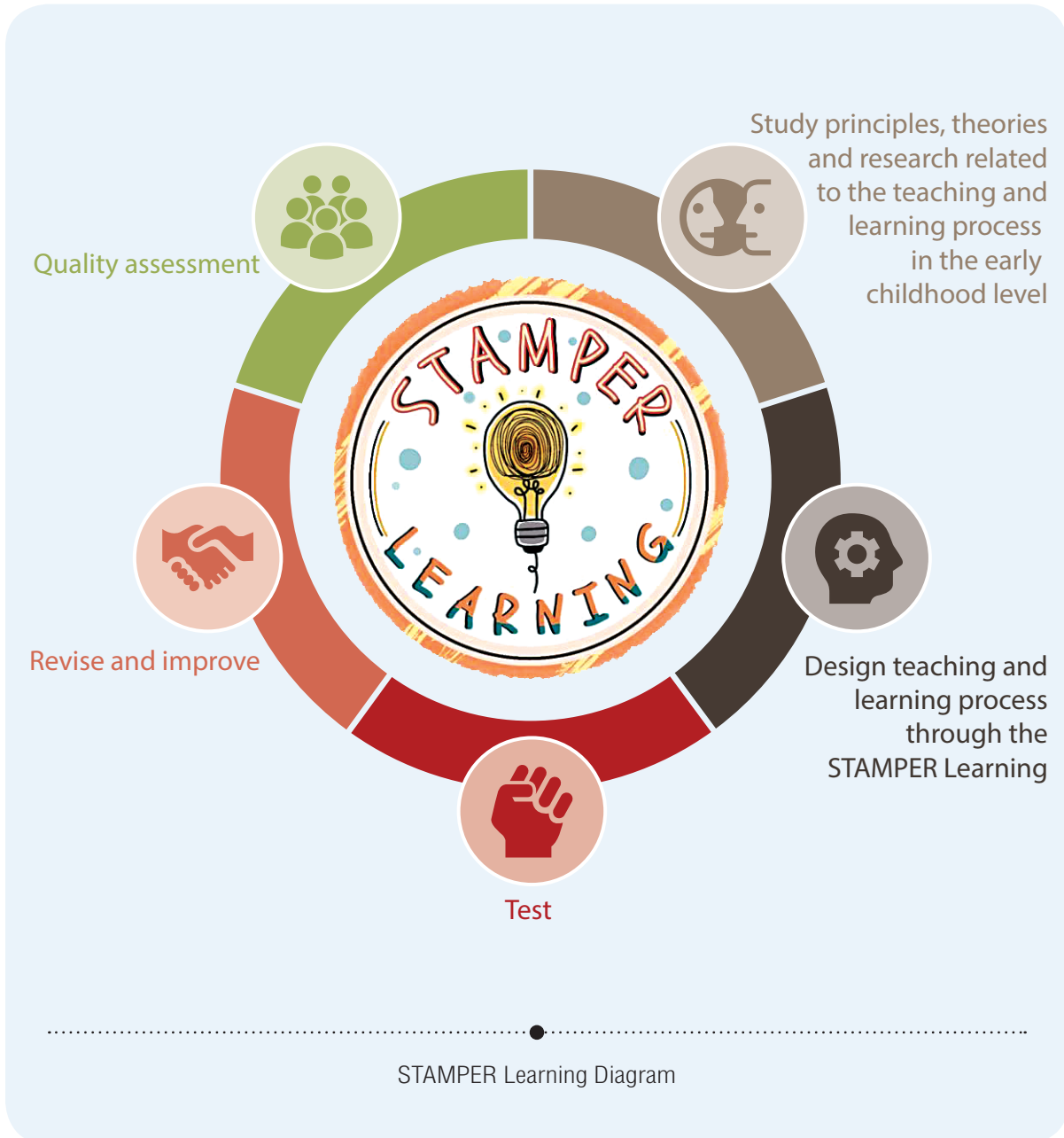
Namkang Saenhanchai, 1ˢᵗ Grade

Assistant coach

I like making toys to play with friends. I like the IMAGINE step the most because I can draw pictures and design what I'm going to do. My problem is when using a glue gun, I'm always afraid that hot glue will burn my hands. So, I need to be careful and try to use it often. I will help my friends with using tools in Makerspace corner and, after finishing class, help the teacher clean and keep things in their proper places.

My dream teacher is the one who is kind, speaks nicely, and gives me 'good girl' stars.

Somphon, 2ⁿᵈ Grade

A pencil case inventor

Learning with Teacher Pim makes me like drawing and inventing more than ever. Back then, I wanted to make a pencil case because I could keep my pencils neat and easy to use. There's no need to pour out the bag, and my pencils won't break too.

If I can create anything, I want to make flowers from beautiful colored paper with stems made of chopsticks. Plenty of flowers make this world beautiful because flower colors are beautiful.

The Skills Builder

Nichapat Teerabunyapon
Wat Pa Daed School, Chiang Mai

Nichapat Teerabunyapon, or Teacher Eid, has always been interested in finding new ways to develop teaching and learning. When she had an opportunity to visit Starfish School, she came across a concrete method in the form of their Makerspace, and was inspired to do the same for her school.

Although the support for school reform had been uncertain at her school, Teacher Eid decided to step over the obstacles and did what she could. She started with designing a classroom environment to create a new learning atmosphere which is flexible enough for students to learn by doing.

Before visiting Starfish School, I personally was an active teacher. I like trying new methods for teaching and learning that allow students to practice. After visiting Starfish School, I learned many techniques and things. I felt that this was a teaching method I liked, and wanted to know more.

Firstly, I took a lot of photos to do the same at my school. However, I was a bit worried about how to do it with a limited budget. Then, I started by organizing a learning environment. Starfish School uses recycled items or easy-to-find objects to create a classroom atmosphere, so I decorated my science classroom with a tree made from plastic bags. I also rearranged my classroom to be more spacious for students to do activities. Now there are not many desks as before because I took out some desks. These desks are not fixed and students can move their desks around to sit anywhere in the room.

The Little Constructor

Wat Pa Daed School had a project to renovate a classroom into a Makerspace for career-related activities, similar to that of Starfish School. However, instead of waiting for the room to finish so that the activities can start, Teacher Eid crushed a new idea of turning the classroom renovation into a Makerspace activity in which students could play the role of interior decorators, and design their own room freely through 5 steps of the STEAM Design Process.

The children's hand-built learning space has become an amusement park of creation that allows them to combine imagination and creativity into the learning process to create a tangible innovation. This develops positive assertiveness in children and builds self-awareness of their aptitudes, abilities, strengths and weaknesses. It also makes them understand individual differences, value themselves, express their thoughts, feelings and actions with confidence, and get inspired to achieve success.

I then asked the students if anyone wanted to make this room and how they wanted it to look like. They showed me their design and all materials they needed. I told them that they could do it the way they want. So, they teamed up and figured it out together.

Now they got a chief constructor, constructors, and a construction plan. The most indispensable person in this project is Teacher Eid, a contractor in charge of production control.

As an advisory teacher of Makerspace, Teacher Eid has expressed her faith and belief in children's potential, built trust and friendliness, and created a safe environment that allows children to express their opinions, with their teacher's support and encouragement.

I was in charge of this project, but I didn't control so much that they had to put things here and there. No, not at all. Firstly, they already knew what Makerspace was. It was a room with glue guns, boxes and colors. I asked, "We have a room like this, what would you like to learn here?", "This is unlike an old classroom, how would you make it attractive?", "You can manage it yourself. It's up to you." I talked to them like a friend, not a teacher. I didn't even have a budget, but if they were hungry, they could order some food and put it on my bill.

There were some things we needed to buy, such as wire nails, just 20 baht. They used an old door and window frames. They consulted a janitor and designed a schematic plan, which I still keep with me. This plan showed all equipment they would use. They helped each other saw and cut wood. But after working to a certain point, they said it wasn't okay, it didn't look modern enough. So, they tried looking for pieces of lattice to decorate more, and built a glass window area. They did as they had planned.

Their plan changed a few times because they experienced problems. They discussed among the team and even submitted a file folder report to me, as if I were a real construction contractor. They wrote that the employer was Teacher Eid.

These amateur little contractors' craftsmanship in interior design might not be one hundred percent perfect since perfection is not a goal of the STEAM Design Process learning. Learning by doing and observing mistakes for further development are actually what teachers should expect students to reflect from their work activities.

They weren't satisfied with the Makerspace room yet. They reflected that the lattice wasn't firmly built and needed to be improved. They also wanted to have a computer to search for information. There used to be a teacher desk in the room, so they asked me if they could take it out or not because they didn't want the teacher to only sit in this room. Finally, they put window frame as a partition between the teacher's desk, and covered it with clear plastic sheet to make coffee shop-style glass window. You have to come and see if it's beautiful or not. But most importantly, the children are proud of it.

This Makerspace, a creative space by Teacher Eid, has begun by letting children design and decorate their own space. This has built the culture of producing things from the start, which will be passed down through generations and be a strong foundation of students' thinking process in the future.

Now this group of students has already graduated. The younger ones in a team who used to help out with their work will take over this project and be the next generation contractor.

A children space built by children for all children

Teacher Eid pays great attention to setting up a learning atmosphere in both the science classroom and the Makerspace. These spaces all allow students to get involved in designing the learning environment as they want, and create a true sense of ownership.

I believe that when we do what we like, we can do it well. We usually do what we're interested in. If children create a classroom by themselves, they will want to use it. Normally, the teacher will decorate each classroom and design room corners, such as a reading corner, a board of 7 days in a week, or a multiplication table. If children can create a classroom atmosphere to be like home, I think coming to school won't be like a study time but more like a vacation.

When the classroom is not owned by just a teacher but all students as well, it means everyone has to share the responsibility for taking care of the space. If someone does not keep the room tidy, how will they cope with the situation ?

There have always been problems, and we need to take a lot of trial and error. For example, I allowed students to use the Maker room at any time and this caused the room to be dirty. So, I discussed with other teachers to find out if it was because students didn't know or teachers didn't inform. We solved this problem by talking with all students about what happened and how should we settle an agreement. Finally, punishments were proposed by students, such as, if the Maker room wasn't clean, then all students from that class would have to abstain from using the room for a week and had to clean the room for a month. Besides, any missing items must be found back as soon as possible. After they set their own rules, the items have never been lost anymore and the room has been cleaned.

New Room, New Students

Setting up a learning environment along with STEAM Design Process activities can help achieving satisfying results that are reflected through the students' changing behavior and participation. Teacher Eid can obviously notice these improvements, especially the children's positive assertiveness and keenness to develop their work.

The first thing I've noticed is that children are more assertive and confident to answer my questions. They don't just stay silent. They share opinions and sometimes play a rock-paper-scissors to take a turn during group activities. They discuss more and play less. What I've seen is their enthusiasm to learn and do activities. They also create rules by themselves. Most importantly, they're proud of their work and want to develop their own workpiece.

Similar to building a house to please the dweller, we should construct knowledge to please the learners. Teachers who have changed their role from lecturer to be a facilitator should work as a learning constructor, and tailor knowledge to meet children's interests and aptitudes in order to help them grow up confidently in their own way.

If I order them to do work, I think it won't be successful. It's like when the school administrators told us to do this and that, but we didn't want to. So, we have to let students open their minds first rather than framing them. If I tell students to make a face mask exactly like this, it won't be possible. Instead, I'd better tell them to design a COVID prevention face mask that they want to wear to school and can actually use it. It can be in any design and made of any material or any media. It can be a rabbit, alien, or whatever shape. I think children will do it happily.

Coaching teachers to understand the curriculum and develop learning plans and learning activities to be suitable for learners, and giving teachers the opportunity to design their own learning management are the key drivers of change in teaching and learning part for the whole school reform.

I personally think that if I have to teach by standing in front of the class, I may not be able to be a good teacher. But after trying this new method, I feel happy to design my own teaching freely. I definitely prefer this teaching method.

Students' voices from Ban Pa Daed School

Pawarit Nuanchan, 6th Grade

It's great that I can utilize things created by myself. These activities are challenging. I could design any corner of the room. I had a lot of trial and error, like playing games. When a problem occurs, we must work together to solve it. If we can't fix it, we can ask the teacher. For me, the hardest thing is to hammer nails because they always get crooked. I asked a janitor to teach me, and now I can do it.

My dream teacher has to be beautiful, up-to-date, have various teaching techniques, and not complain or scold. My dream teacher should let us do the work rather than lots of writing.

Pongkhun Phairoh, 6ᵗʰ Grade

I want to make a room for younger children to create things. It's cool to design a room from our ideas. I like to take trial and error and choose many materials we like. The most difficult part is to find this material (a window frame). It was a very heavy piece of wood, so I had to ask many friends to help me lift it. I told them that I would use it to make the Makerspace room.

My dream teacher is the one who is kind and always give us advice. He/she shouldn't scold when we do something wrong, but encourage and support us instead. Also, he/she should let us use computers to find knowledge by ourselves. Do you want the teacher to read for you ? I prefer to discover by myself.

Somruethai Thanasarn
Wat Chang Khian School, Chiang Mai

For teachers who have read to this chapter and feel that the STEAM Design Process is interesting but too difficult to implement in their schools due to many student's limitations, we would like to introduce Teacher Somruethai and her teaching team from Wat Chang Khian School, who have applied the STEAM Design Process to their unique model aircraft invention activity, taking children to fly across the constraints of physical limitation, race and language, to successfully develop their skills and abilities.

Based on the model aircraft invention activity, a wide range of lesson plans can be designed for many class levels with the broad, narrow, or deep learning content that differ for each learning stages. This will help children to develop knowledge and skills from basic to complex levels.

The method that can be considered as the best practice of this activity is to have experienced senior students mentor the younger ones. These senior students have already gone through the process of learning, practicing, making mistakes, and fixing problems successfully. Therefore, being entrusted to teach younger students is an opportunity for them to grow up and develop themselves to the next level.

Our school's Makerspace activity is the model aircraft invention, which is unique to our school. About 50 leading students from kindergarten to 9th grade are learning with senior students who have competed in the model aircraft invention contest in the student Arts and Crafts Fair, while teachers are just observers. For the kindergarten level, they

create paper planes from their imagination with any materials. Students in the first stage will create a walkalong glider from thin foam boards that can fly as they walk along. Students in the second stage will make a long-flying glider and a rubber band powered glider using styrofoam and additional materials like balsa wood and bamboo to make it look like an airplane. In the third stage, students will make a 3D glider from styrofoam cut into various model planes powered by a rubber band. There is also a radio-controlled plane that has just received the 1ˢᵗ prize Royal Award. So, students in each learning stage will learn to create different types of model aircraft. When they step up to the next stage, they will learn a new one.

After having a study visit at Starfish School, Teacher Somruethai found mutual characteristics of STEAM and STEM that teachers and students are already familiar with. Therefore, she had an idea to apply the STEAM Design Process to her science class in addition to the Makerspace activities organized by the school.

I applied it to science class because my 7th grade class is learning about science toys. The STEAM Design Process made it much more fun. I designed a 'Mail-across-the-canal' activity which the situation, letter and the canal size were provided, while they had to think about other materials by themselves.

Students' resistance

For some students who are familiar with doing worksheets and being spoon-fed, when they first encounter the STEAM Design Process that requires more thinking and doing than usual, they may not be ready to accept. Teacher Somruethai has to adjust her approach to gradually embed these processes into their mind and patiently change the children's mindset.

When I first used this process, I didn't use all 5 steps, just starting with the first and second step; ASK and IMAGINE, because students were quite opposed to this activity. They said, "It's very difficult." because their thinking was very slow and took a long time to get an answer. Comparing to previous learning that they didn't have to think about anything, this was chaotic. I told them it wasn't difficult. "Just let it into your process, and then it'll become easier." So, I had to gradually include it into each activity. Once the children were comfortable with ASK and IMAGINE, I then let them try the PLAN. When these 3 steps were fine, they went on to CREATE and continued to complete all 5 steps of the process.

Once we finished all 5 steps, students aren't resistant anymore. They'll go through every step by themselves. At first, they need to think and ask themselves what the problem is, how they're going to do something, and what's next. We have to instill it into children's thinking processes.

Broad problems require precise reflections

Teacher Somruethai tried to design challenging activities by inviting children to think about how to create a workpiece that best corresponds to their learning. Therefore, her assigned tasks were widely open for children to exercise their imagination beyond limitation. However, imagination may sometimes not lead to success when it comes across real-life limits. Hence, activities that encourage reflective thinking among team members will help children solve problems and develop their work to eventually reach their goal.

For the kindergarten class, I set up a situation in which we would travel to another province without a car or motorcycle. With all materials I provided, what would students do to travel across the sky? I gave them cardboard tissue rolls, drinking straws, popsicle sticks, colored papers, glue guns, play dough, cotton and colored pencils, and then let them design their invention. They asked me whether they could travel by an airplane or a rocket, something like that. The work came out crazy and didn't look like airplanes at all. But it was cool that even, in the end, they didn't make it look like an airplane.

Older students did a 'Mail-across-the-canal' activity. The situation was that if they didn't have a boat and couldn't use a bicycle, what would they do ? Some groups chose a simple way, some didn't get the question. Not everyone could get it. There was a group that planned to throw like the Angry Birds. Some planned to make a model plane with an attached motor making it controllable to drop a letter safely. This one was later accomplished as a work piece and was tested in sending mail across

the canal. Children had so much fun. However, my observation is that I let them listed out too many materials, most of which couldn't be found. The work wasn't 100 percent perfect as they planned, so I had to lead them to the fifth step; REFLECT & REDESIGN, to revise and improve the design in their own way.

Certainly, wide-open questions will lead each student to work on different experimental paths which may not be in a straight line, especially exceptional children who are more likely to take several stops along their journey. Once they reach their destination, the important thing is to ask them to look back at the path they have taken, and analyze their past work together in order to help them reach their destination faster in the next departure.

Importantly, teachers should have a positive perspective, understand students' characteristics and know when to give them advice, and be able to use words to encourage their learning. This will help children to be able to confront obstacles and be ready to move forward.

When I specified a detailed problem, for instance, there were a rubber band, a 30 cm long stick, and a 5 cm wide with 10 cm long letter provided, they would be a bit stressed and didn't know how to put them together. But when I let them imagine freely, they would come up with so many ideas. "I'll put 6 motors on and take off like a bomb." That was totally imaginative and we had to let them be because it was their proud moment.

For exceptional children, if I had popped their bubble that day, they might have lost confidence. So, I first gave them compliments, and later gave comments during the reflecting session. If they did their job and failed, I would ask for the reason behind the failure. They would then be able to explain why. I didn't dare to stop their imagination. As a result, about 80 percent of the children accepted the reflection, while another 20 percent, according to the child's nature, didn't understand why it failed. Some children in 80 percent knew it failed because they were too imaginative beyond the provided materials. Some of them had too simple of an idea. They could reflect all by themselves. However, what they received for sure was happiness. They smiled, sometimes a secret smile, which made me happy. Whenever they speak more than ten words, I will be delightful.

Makerspace is a place for all children to be heard and accepted as part of a team. The STEAM Design Process offers them the opportunity to express their opinions, do what they enjoy, understand and be proud of themselves, and understand other people's differences. They improve their self-esteem while accepting thoughts, feelings and actions of others. Moreover, this process is an achievement and motivation that inspires one another to accomplish a goal together.

These little planes do not only advance the children's thinking and planning skills to the next level, but also help develop social skills for those children with special needs.

So, it's the spark that these exceptional children, who normally don't speak at all and just sit in the corner of the room, can now speak and talk with friends when they work in a group. During the STEAM Design Process, one of them with a learning disability gave a suggestion to the team that they should attach sticks together to make a bow. Friends listened to him, even though he was often teased in the class. He had become more accepted by friends during these activities.

Play and Learn Approach

Teachers in many schools are often responsible for organizing special learning for exceptional students, which requires extra consideration on the suitability of their development level and interests. Teachers must focus on practical skills, and closely observe and assess their development progress to enable exceptional students to learn and work at their full potential with other students in a regular classroom.

The STEAM Design Process will help exceptional students restore relationship skills that enable them to understand other people's perspectives, emotions and feelings, communicate their own feelings, and work happily with others.

I first put an exceptional student into a group. It was exciting to see him speak because normally when I asked, he would avoid eye contact, put his face down and get stressed. If he started spitting or biting himself, I wouldn't bother him. But when friends were discussing during group work, and I was just listening to them as an observer, he suddenly spoke up like "Why don't we make it like a shooting bow ?" His Friends said, "Alright, how do you do it ?" They questioned and answered in the team. Friends told him that it was an excellent idea and asked where he got it from. He said it was from a game he played. It turned out that his idea was useful to the group, which cheered him up and made him want to keep going on, smile and talk with others more.

It seems that playing games is an activity that goes well with children's competitive instinct and encourages both thinking and practicing skills. These activities also help exceptional students reduce stress and study as if they were not studying.

Designing activities that meet children's interests by letting them practice often will give them an opportunity to show their abilities. Learning through fun activities helps bring exceptional children out of their own world to the outside world. This concrete change can be seen in Teacher Somruethai's Makerspace.

Children normally like competition. So, I just made it like a game with losers and winners. I divided them into groups and let them compete on who would deliver the letter most perfectly, hit the target, and the farthest. Normally, exceptional children would sit still and speak only a few words when friends asked. But after I made it like a game, it became a recreational activity for an exceptional one. When I kept conducting activities like this more often, he gradually accepted and opened up.

Although the STEAM Design Process provides opportunities for everyone to have fun and learn together without discrimination, some students may feel that working with exceptional students in a team will cause difficulty and have less chance of winning the game. For that reason, after getting through this learning approach together, they will be equipped with the skills to coexist in differences. The STEAM Design Process thus helps promote a social inclusion and human values in the school society.

I have to talk with his classmates, tell them that their friend might be excellent in some areas that they didn't know about previously. "Let's try first. If you already tried and still think it's not okay, we can discuss with the whole class." Normally, students at Wat Chang Khian School don't bluntly refuse to be with exceptional students. They wouldn't mind because every teacher here kept highlighting that an exceptional child is a normal child. There were some times when an exceptional one suddenly stood up and ran out of the classroom, friends would run to calm him by patting on his back and arms, and then lead him back to the class. Even when an exceptional child urinated in classroom, they would take him to toilet. During a field trip, they always have a buddy to take care of. This is an advantage of the students here. Any exceptional child here would never feel alienated or be disgusted at all. They're very fortunate.

A Classroom where everyone exists

The students at Wat Chang Khian School are highly diverse, including exceptional students with autism, learning disabilities, and down-syndrome. They are studying together with general students. There are also students with extreme age differences and foreign students with Thai language challenges, which is a major obstacle in learning. However, regardless of who they are or where they are from, every student can learn together happily in Teacher Somruethai's Makerspace.

The Makerspace with learners from different ages has unbelievably become an advantage. When a teacher noticed the leadership of older students, she developed this potential by assigning them to be a teaching assistance team for the STEAM Design Process activities. This additional duty will help these little assistances sharpen their knowledge and skills as well.

Our foreign students have significant age differences; some of them are 18 years old but still studying in 7th grade. However, they're quite good at social skills. While I was teaching in the Makerspace, this group of foreign students assisted me in nearly 50 percent of my teaching. They have leadership because they're more mature and able to make everyone listen. For example, in the Makerspace activity, these assistances first learned about model airplane that younger students would make. If the plane crashed, the assistances would ask why and how to fix it to make it fly further. The younger students from 3rd and 4th grade would answer and try fixing it. Before these assistances could become a coach, they must be guided with the 5-step process again by teacher.

During an opinion exchange or criticizing session, there is a high probability for students to not listen to each other's opinions, not to mention in a classroom with such diverse conditions. If an agreement has not been settled upon before the activity begins, the reflection at the STEAM Design Process's final step is possibly chaotic.
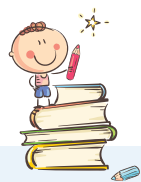
The teacher's rhetoric is essential to inspire and foster a positive learning environment and encourage children to work in collaboration with each other. Teacher Somruethai has encouraged her students to accept each other, learn and work as a team, and solve problems together. She also let everyone express their opinions and give feedback on the workpieces, enabling all team members to accomplish the work together. These roles are part of the most important skills for the 21st century teacher, which is to become a learning collaboration builder.

I try to let them be bold, and to speak and express themselves. Suppose that if someone proposed an idea, friends might say that it's not right. I'll let them listen, talk, discuss and prove. Before doing something, an agreement must be made first because children sometimes think their opinion is totally right. When someone disproves their opinion, they would get upset. So, we must agree that we're committed to do everything to find a solution and reach the finish line together. If anyone of us reaches the finish line, it doesn't mean only that person wins, but everyone in the class also wins. We help each other connect the bridge. Teachers have to have persuasion skills to unite them.

In conclusion, to become a skillful teacher in the 21st century, teachers must change their mindset first, and then the progress of students' thinking process will ultimately come to fruition.

First, we have to open up and accept our students. Even if something they said is not right, we have no right to judge. We must ask them, accept their opinions and decisions, and try to connect the exceptional children with the general ones to learn together and accept each other's identity. In my class, everyone must be able to participate. Everyone must learn and express their opinions. Everyone must accept different opinions from their friends. Everyone must coexist.

Students' voices from Wat Chang Khian School

Noom Loongdaeng, 7th Grade

I like Makerspace because I can practice a thinking process and enjoy inventing. I can design a model plane to have the longest flying time with the best balance. During the activities, I usually give friends advice when they're about to invent something after discussing the ideas.

Noommueng Nathong, 7th Grade

As a teacher's assistant, my responsibility is to keep an eye on safety and take care of exceptional students' tempers. I like Makerspace because it lets me practice. We have to think of how to make the best use of all materials that will make a model plane fly as high and long as possible. It lets me practice my leadership as well.
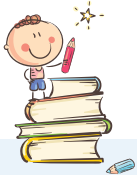
Pang Poi Maker

Siriphorn Techanan
Ban Pang Poi School, Chiang Mai

Effective whole-school transformation requires not only physical improvement but also cooperation from all parties, especially teachers, as they are the key human resource to drive change. However, it is not easy to change an old-school teaching style or values, just like Teacher Siriphorn of Ban Pang Poi School had tried to do amidst the constraints of poor facilities and fixed mindset of fellow teachers, who did not believe that new teaching and learning methods could actually change the students here. Hence, introducing teachers to a broader educational aspect will be a significant solution to shift the paradigm and lead everyone to pursue the same goals.

When I first came to Pang Poi School, there was nothing. The school building wasn't ready and the classrooms were inadequate. Students came to school, but not so many. Later, the school director made a change by inviting the community to be a learning resource, helped lessen parents' burden by offering a school bus to pick up their children, and improved facilities by finding every possible source of budget. From having nothing, now we have many more buildings within 5 years, which is very fast.

Someone said Pang Poi was previously in a dark age. They worked day-to-day. Teachers just taught without bothering if students were getting better or not. But after the facilities were developed, it was also time for teachers to focus on student development. Unfortunately, there were still some teachers who thought that these students couldn't be developed. Those who also taught these students' parents even believed that Pang Poi students couldn't be improved. The director said we couldn't blame the children like that.

He tried to change the teachers' mindsets by holding several meetings. Personally, I was ready for change, but I alone couldn't change others. So, I suggested to have a field visit at Starfish School because I had been there before and was very impressed. I wanted other teachers to see what I've seen so that they would understand the direction we were moving to. That was our beginning.

Pang Poi Banana

Before applying the STEAM Design Process, Teacher Siriphorn was responsible for conducting the King's Philosophy activities by arranging 5 learning bases about the Sufficiency Economy Philosophy. Her teaching just followed the curriculum with some learning resources to practice, but did not have a clear learning process. Previous to visiting Starfish School, all 5 bases were re-designed and adjusted to be the Makerspace letting children learn what they were interested in, within the concept of promoting occupations in the community context.

Previously, we focused on career-related learning because our students' background is that they're from tribal groups. We wanted to focus on enhancing their occupational skills. But after visiting Starfish School, we had some adjustments. I discussed with other teachers of the 2nd key stage about making our own Pang Poi Makers to let children learn from their interests. We used to have the Moderate Class - More Knowledge session and adjusted it to 5 learning bases: Pang Poi Banana, Veggies for Healthy Life, Organic Mushrooms, Green EM, and Happy Livestock. Then we changed the class management. Instead of assigning children from the same class grade to one learning base, now we allow them to freely choose to attend a learning base according to their interests.

When applying the STEAM Design Process to each learning base's activities, the teachers who design activities have to adjust their teaching methods to encourage active learning in different styles. Seeing that the teachers have changed their role from a knowledge dispenser to a learning facilitator, learners also have to change from being spoon-fed to a knowledge creator getting involved in constructing their own knowledge.

My learning base is the Pang Poi Banana. Previously, I used to teach by showing YouTube recipes of banana chips, dried bananas, fried bananas, and then let the students cook following the video clips. After applying the STEAM Design Process, I changed to let children create their own recipes. Suppose they were going to make bananas in coconut milk, they would write a plan first with an unlimited imagination. Their recipe could be unique by adding Bua Loy (rice-flour balls), butterfly pea flowers, coconut, or anything different from usual recipes. The taste might be weird, but that's fine because they could make and taste it by themselves. Like when they made donuts and added new ingredients, the first taste might not be nice, but they said it was delicious, which was fine for me because they were proud of their work. That was the first thing I noticed. They kept saying it was delicious, while in fact, it was far from that. So, I let them present why they added those ingredients.

A space that allows children in all key stages to learn through play and experimentation with integrated scientific and artistic knowledge will help adjust their mindset from being a consumer to a producer. Pang Poi Maker is an example of the producer culture base, which is in demand for Thai education.

Children in 4th grades had so much fun because activities for the 2nd stage are more challenging than the 1st stage. When we noticed that the 2nd stage students were doing well, we decided to apply this learning process to the 3rd stage as well, in which students were more creative. For example, while students in the 2nd stage were learning about Namwa banana, the 3rd stage students had to make flour from raw bananas. We let them think about what they could do with banana flour, such as making Thong Pub, Thong Muan, Dok Jok, cookies and cake. Their Thong Pub was quite unique. It was herbal Thong Pub made of banana flour, coloring with butterfly pea flowers and okra. They kept trying new recipes. The first attempt was not a success. A piece of Thong Pub was ragged and uneven. So, they constantly reflected and solved the problem until they got the right recipe. With the STEAM Design Process, students were fun to create their own recipes rather than follow a recipe told to them by their teacher.

Teaching without teaching

Being a learning facilitator can be both easy and difficult because teachers will not teach or dispense knowledge all the time, but instead being available when children need support. However, it may be quite challenging for teachers who are used to being a knowledge dispenser to cease themselves from overly thinking or doing things for students.

In order to encourage students to develop their thinking, teachers must change their methods from dispensing knowledge into raising questions throughout the learning, in order to invite learners to review, process, and think about what they are doing. This will cause more in-depth learning and reduce the class hours by not spoon-feeding information, which will shut down the students' learning process.

I think the hardest part is the CREATE step, because I have to control their work but try not to do it for them, just let them do on their own. Still, I must be with them all the time and keep asking, "Is that ok ?", "Is this amount correct?" If they said yes, then

I was alright. Previously, I always told them the recipe, what and how much of each ingredient they should add in, and the taste could be quite nice. But when they thought on their own with trial and error, it would take more time and become a bit chaotic.

Although there has been little success, it can confirm that even with the limited supporting factors, the STEAM Design Process in learning management is able to work effectively to help underprivileged students develop essential 21st century skills based on their personal potential.

It allows them to think and practice. When they practice, they feel happy. Firstly, I asked some students why they chose to join the banana base. They said it was because they would definitely have a chance to eat what they cooked. This group of students may not be academically talented, but when they actually practicing, their behavior and assertiveness really improved. For me, they don't have to make a perfect change, just 10 or 20 percent is considerably good. Pang Poi students are from tribal families with struggles and resource scarcity. So, it's great that they can improve to this level.

One factor for whole school development is the use of innovation and technology to appropriately support the learning management according to school context. Its indicators are: teachers apply technology to produce learning materials and support learners' learning activities, and for learners have literacy skills as well as being able to use technology to access resources to support their learning.

At Ban Pang Poi School, despite the student's scarcity issues, Teacher Siriphorn has tried to introduce technology to students. She strongly believes that by training them to think, do, and expand the horizons of their knowledge little by little, they will eventually be able to keep up with the world.

After I attended the Active Learning: Thailand 4.0 workshop, I applied it to my students and told them that from now on, we could sell not only at the school's cooperative store but also on online platform. My intention was to teach them only about the process. I wasn't serious that they had to actually make a sale. I just wanted to teach them that the world has changed, we could sell not only in the community market but also in the online market. We just need to create an interesting package, logo stickers, QR Code, LINE account and Facebook page as the sales channels. I just let them try. There was no need to actually sell it.

I started the Facebook page myself and let them help operate. Firstly, I wanted them to make live sales, but they were shy. Pang Poi students are normally shy because they're tribal kids. I try to post photos of them and tell them to follow our page. I try to show them that we can sell our products this way.
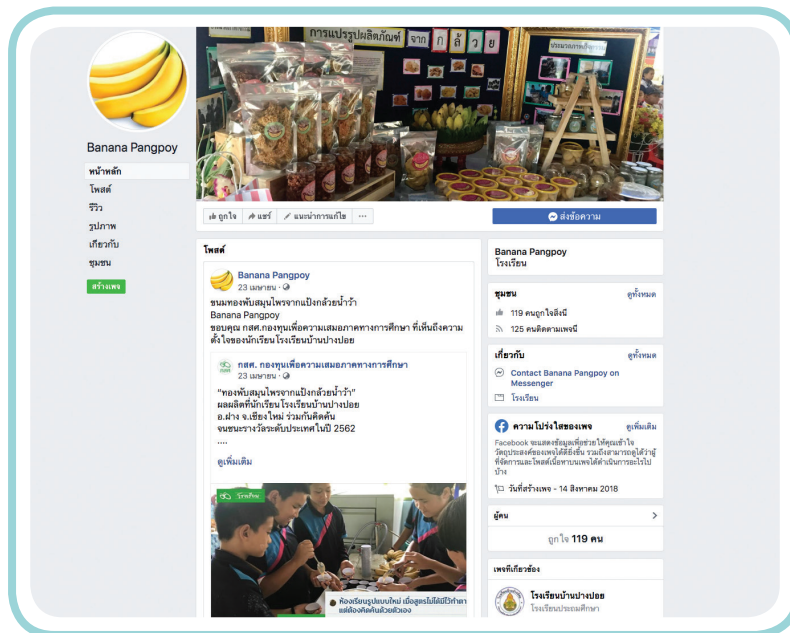
🖍️ The Competition

Who said Pang Poi students couldn't change ? Within just one semester, Teacher Siriphorn was able to see the outcome of the STEAM Design Process, whether more systematic thinking and, most notably, an increasing confidence that finally brought them success in the competition and they won the award.

Although the award is not important, it proves that the STEAM Design Process is the right path for developing 21st century skills, as these students have demonstrated in real arena with real audiences and real assessment, not just in their classroom.

The first change that occurred in children was assertiveness. When we let them do activities with the STEAM Design Process, there would be planning, imagining, creating, reflecting, and then presenting that they had to speak out. When they were proud of their work, they would be confident to say why they created this recipe. They would say that because it was delicious. They could at least say something, even just a couple of words. I think that was great. If they kept practicing, they would become more assertive.

I believe that a competition encourages children to develop and be more confident. So, I tried to take students to join the food transformation skills competition in the OBEC's Arts and Craft Fair, which they could finally reach to the regional level.

In the competition, they had to make and present before the judges. The judging criteria were uniqueness, processes and practicalities, and presentation. This level of competition was considered as the starting point for our students because they didn't have any confidence. They were confident only when speaking in their native language, not in Thai. When I visited Starfish School, the students there were very confident to speak and present their work. So, I got an idea to train my students to speak, even one or two words, just speak. In the competition, their competitors were top students from many provinces, and those urban students were certainly assertive. When our students tried to speak, I was really thrilled because sometimes they spoke very softly. However, I told them that they did a good job. It was great for them to have a stage to demonstrate their skills. I didn't expect any awards but their experiences.

After noticing that children had improved their speaking and assertiveness, Teacher Siriphorn, therefore, had an idea to extend the learning within activity base by training the first batch of students to be learning base lecturers, which helped them develop exponentially and became a model for other Makerspace bases in the school.

It started with those students I took to the competition. When they were confident enough to speak, I trained them to present their learning base on behalf of the advisor teacher. Many schools were interested and visited us, and our students could confidently present to them. When teachers of other learning bases had seen how successful we were, they began to train their students in the same way. Then, this process was extensively applied to the whole school.

Before the end of the semester, the school director held a "Share and Learn" activity to summarize the results of the STEAM Design Process in all activities in the whole semester. Students had so much fun that day. They could eat, play, and do everything freely.

I considered it as a beginning. It wasn't yet an Open House activity because we wanted children to learn from each other first by visiting other friends' bases rather than sticking with their own base. In the "Share and Learn" activity, students from all class levels performed well in presenting their work. So, I assumed they understood the process, which would make it a lot easier in the next semester.

Despite many obstacles in terms of facilities and a fixed mindset of fellow teachers who do not believe that new teaching and learning method will make changes to Ban Pang Poi children, the STEAM Design Process has become the strength of Ban Pang Poi School's teaching and learning management in just a short period of time. This whole-school transformation can successfully happen due to the firm belief of the School Director, Jongrak Kantha. He stated that "The good educator must believe that each child is different, and amidst the differences, children can learn and develop regardless of their race, language and ethnicity. As long as teachers have faith and hope that education is life, we will be happy and ready to fulfill children to strive forward on their life path."

Students' voices from Ban Pang Poi School

💡 **Kanthika Thamphan and Kornkanok Sathoom, 9th Grade**

We like coming to school because we want to do activities with friends and learn new things that can be applied to daily life. We like Pang Poi Banana learning base the most since we can make and eat our creations. The thing we like most is the dessert made from a recipe we created.

The hardest part was designing the dessert because we had to make up our own recipe. At first, the dessert did not taste very good, or was inedible. It was an experience that made us know which ingredients we could put in. Another common problem was precise measurements. Our solution was writing it down when we found the right recipe so that the problem wouldn't happen again.

We like the teacher who understands students and can be a counselor for all matters. Studying with our dream teacher should be fun, not stressful, without scolding or too much writing, but letting us think and practice by ourselves.

Everywhere is a Makerspace

Aree Kannika
Ban Kong Khaek School, Chiang Mai

Starfish Maker is a 21st century skills development program using a project-based learning process through a creative space called a "Makerspace" that allows participants to create things based on their interests and expertise. This space helps learners to get familiar with systematic problem-solving, and grooms them to be thinkers, problem solvers, and rational people. Makerspace can be arranged in many forms, such as a specific room, the corner of a classroom or library, or also a mobile set for activities in a learning unit.

Schools with facility limitations like Ban Kong Khaek School can adapt these activities within their available spaces, and apply objects that are easy to find in the local community to be craft supplies for the little creators. As long as the STEAM Design Process is implemented in Makerspace, the development of 21st century skills is always possible.

We've arranged it as a corner in classroom because we cannot afford a specific room. It's a craft corner with unused items gathered from students' houses, such as soda bottles for making toy cars, or branches, leaves, and natural materials around the school. At the art corner, we provide work samples and students are allowed to use any type of colors. For P3 students, they normally use colored pencils and crayon rather than watercolor. Students are mostly happy and interested in doing activities like this.

Applying standard indicators as the creation's problems

Apart from the Makerspace corner for students to practice skills in their extra time, Ban Kong Khaek School also implements the STEAM Design Process to the main curriculum subjects by interpreting each subject's standard indicators to be problems in the student's learning activities.

For example, in science class, students had to learn about water and air, right ? We would turn the indicators of learning standard into the learning purpose and activity's problems. Students would learn about the air first, and before they start learning the air movements, we would let them do activities and conclude the lesson again. It would be a core activity in the teaching and learning process using the STEAM Design Process.

Previously, they created an air powered balloon car because they had learned about the wind and its motion properties. Let's say we had already made a plan and a learning purpose from the unit indicators. After completing the wind lesson, students were asked to design their work with the STEAM Design Process worksheet. Step 1 was to ask how they could build a toy car that could drive itself by using provided materials. Students were not yet familiar with the process, so the teacher had to ask questions to motivate their thinking, like how to make it drive faster or drive as we wanted.
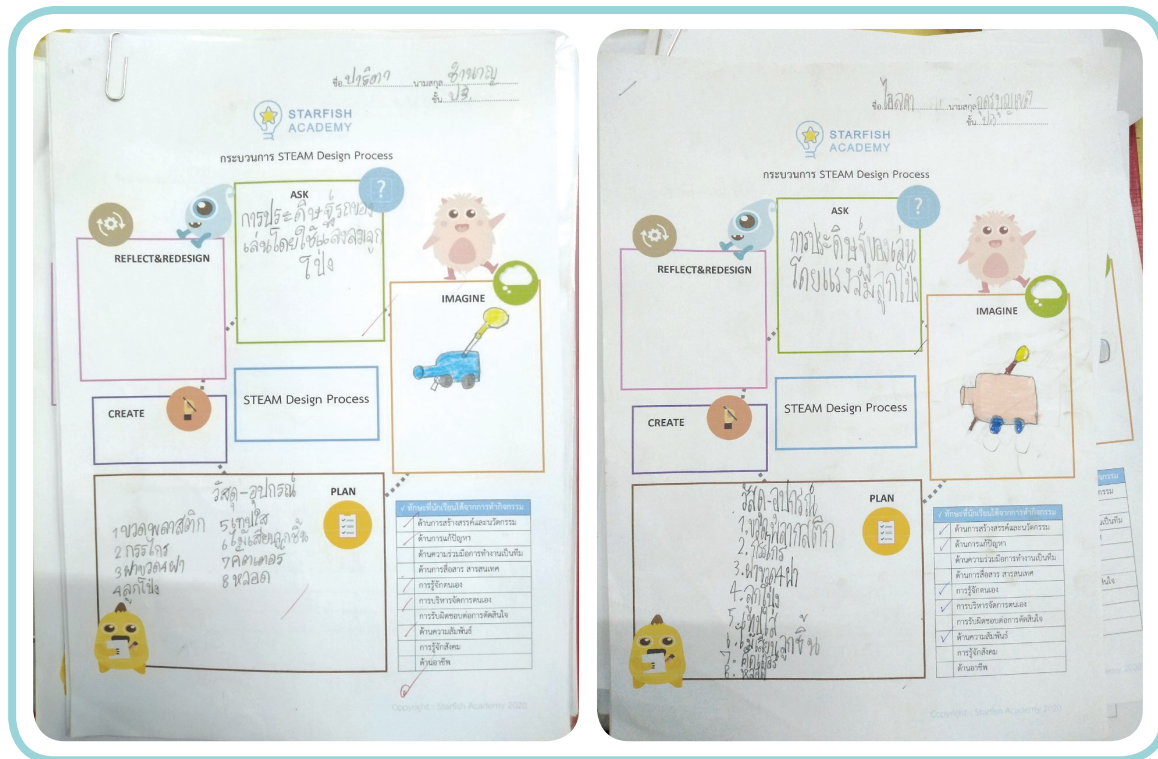
Some of them would use a computer in the classroom to do internet research, some would discuss things they had seen on YouTube or learned from previous lessons. After collecting the information, they would come together to imagine and design how the car should appear or what shape it should be. The teacher would prepare materials including balloons, coffee straws, stationary cutters and wooden skewers. Then, they would design their car by drawing or writing down its feature in the IMAGE step.

After that, each group would plan about materials. There were some materials provided by the teacher and some that they prepared themselves. Then, after they created, they would have a test run to see if there was any problem. They had to figure out how they were going to improve if it was too slow. They might improve the wheels or the balloon. After their work had been done, they had to present it to their friends.

The balloon car making process was quite exciting and interesting for children. The teacher would try to motivate them to share their thoughts as much as possible. They would be happy and fun. Some groups also asked me if they could create the force from a rubber band instead of a balloon or not, so I let them try with another creation.

No child in this world is unable to think

It is always hard to start trying new things. Therefore, it is common that when a teacher begins to train students to think, they may not be able to or can hardly give an answer to the teacher. A revolutionary teacher who wants to see change needs to patiently inspire students to keep thinking over and over again, because there is no child in this world who is unable to think. They are just untrained.

The hardest part is ASK and IMAGINE, that both encourage students to think. If the teacher can't find clear motivating questions, the result will also be blurry. The teacher has to spark them to be eager to know and make them feel that they want to do or think the way we want. In the beginning, our students' thinking was very weak because they rarely had the opportunity to practice thinking. I've been trying to train them by asking questions that they can answer as if we plan the teaching to guide them to respond the way we want. It's not suggestive, but sometimes we have to show them good examples. If they get used to the activities by doing them more often, they will understand our teaching style. Students can become better at thinking if they're trained.

For example, in the lesson about leaves and different shapes of each type of leaf, we discussed about leaves from different places and pressed them in a book. The following week, they created art from leaves and used the STEAM Design Process to explain how each leaf can create a work of art. At first, I was afraid that they wouldn't be able to think because it was a new thing. They didn't usually suggest an idea. But when they went through a few activities, they could know how to go through the process. Some students attached leaves together and designed them as a house or animals.

Sometimes, at the conclusion step, elementary students can't tell what skills they've learned, so the teacher has to help and keep asking. Anyway, the children are happy and fun with the learning compared to general lecture or a worksheet. This method has opened up their mind and given them more chance to express their individual characteristics.

Multi-subject integration through a leaf

Ban Kong Khaek School has been able to prominently apply the STEAM Design Process, especially in designing integrated activities that invite children to utilize the knowledge they learned from different subjects to create their work. Learning about only one leaf can take students to go further in Science, Mathematics and Art, developing both their left and right brain.

The nature of different shapes of leaves is related to mathematics. Drawing the work that they design is art. Shapes are also related to art, while the process design is their engineering learning.

The learning content that uses the STEAM Design Process is mostly from science subjects. It's easy to integrate with other subjects because the scientific method is about researching. The past semester, they learned about living and non-living things. We used STEM for data collection and area measurement. Our school has a lot of lawn and animals, so the teacher would let students explore and gather information about living and non-living things in the designated area without using measuring tape. Instead, they would use materials they could find around the area as a measuring unit. Therefore, they would understand the lesson about a measuring unit they were learning. This was mathematics. For the art part, they would draw pictures of plants. Art was inserted in it anyway. There was no need to separate it as another subject.

For next academic year, I may try to integrate other subjects to mathematics because most teachers usually use science as the main subject. But actually, any subject can be the main one.

Our school has applied the STEAM Design Process to almost every course. We've planned that teachers in charge of each course will arrange at least 1 - 2 activities per semester, or if any teacher can do more, that's even better. For me, if any content is suitable for learning by using the STEAM Design Process, I will do because it allows students to have fun and do something by themselves.

STEAM Design Process helps understand students just as they are

The STEAM Design Process encourages students to express their ideas and confidently reflect themselves in the way they are. At the same time, it trains teachers to see and understand students in a new way without being limited by the boundaries of right and wrong.

Sometimes what we see or understand may not be exactly what children think or be. Some children used leaves to create a certain design, but the result turned out to be another design. When I saw it, I thought it was a pig, but he said it was a chameleon, not a pig. His design was actually a chameleon, but it turned out to be a pig.

The STEAM Design Process requires teachers to adjust themselves to be a personalized learning developer by considering the aptitude and differences of individual learners and encouraging them to search and explore, to be able to understand new things, and integrate their existing knowledge to solve problems in reality. Teachers should also observe learners' interests and aptitude and allow them to do what they are interested in.

About 30 - 40% of our students are from flat plain land, while about 70% are hill tribes. However, communication isn't a problem. They can communicate with teachers and do activities together because the STEAM Design Process allows them to express themselves and speak in front of the class. They're happy to do it. Some of them have gained more confidence and are able to express their thoughts. Some students who aren't assertive are quite attentive when doing their own work. This process seems to bring out their capacity and potential.

Teacher's self-development is also vital

One of the key elements in the whole education system reform is professional development, and the key person in this element is the teacher.

Teacher development in the Professional Learning Community (PLC) can be a good answer for improving the teaching capability. The fact that people who work in the same profession can come together to collaboratively share their experiences, whether they are teachers in the same or different subject groups, schools, educational areas, or in the national level, provides a wider view of learner development in various contexts through examples of best practice operation and challenging development.

Teacher Aree is an example of a teacher who is constantly developing herself, whether it is by attending several training sessions or by being a part of the teacher community, in order to develop her teaching management techniques and help fellow teachers follow the same path of learner development.

Since 2017, we've had the annual STEM training at San Pa Tong Center before the semester begins. I've been participating every year. Activities from Starfish School are also a part of it. In addition to this training session, we've also attended the STEM for elementary education training, which I found no different from STEAM, except for adding the art. However, its success depends on teachers who implement and motivate the process continuously.

Moreover, I've been finding more inspiration from Internet, Youtube, a group of fellow teachers both in and outside the school, and a network of science teachers who attended several training programs and gathered together to create active learning. We also have the PLC in our school where we mostly discuss problems in teaching and learning. It's important for us, as teachers, to always be creative and keep improving ourselves. We have to be good at designing the sequence of questions, and planning the expected achievements and how to lead our students to that goals.

We have to prepare the teaching quite a lot, but that's our duty as teachers. I can say it's our happiness, if we love the teaching profession. When students are happy to study and achieve the learning indicators, the teacher will also be happy and won't see teaching preparation as a burden. It's challenging because we can use any materials around us to apply to the activities. We just have to prepare the integrated teaching, and it won't be difficult to do.

Students' voices from Ban Kong Khaek School

Pannathat Boontiam, 4th Grade

I like teacher who has a wide variety of interesting teaching methods. I also like the Makerspace because I can express what I'm keen on, and freely think and design my own work. The most difficult part is to create. For instance, I found that the most difficult part of making a toy car using plastic bottles with wheels from plastic bottle caps was to find the center of a cap and punch a hole, which was very hard. My solution was asking the teacher to show me how to punch a hole, and then I did it myself.

Prapassara Nimnuan, 4th Grade

I like teachers who make a class fun and don't scold or grumble. I like doing Makerspace activities because I can think and design by myself. It's enjoyable to be an owner of the work. What we've learned can also be used to plan to fix things or plan other studies.

Reference

Starfish Country Home School Foundation: School Leadership for the 21st Century

Special Thanks

Mr. Kittikorn Kong-In	Teacher of Ban Na Mon School
Ms. Monchaya Hinseesuwan	Teacher of Wat Rong Or School
Ms. Wanpisa Pruksama	Teacher of Ban Pa Meud School
Ms. Nichaphat Teerabunyapon	Teacher of Wat Pa Daed School
Ms. Somruethai Thanasarn	Teacher of Wat Chang Khian School
Ms. Siriphorn Techanan	Teacher of Ban Pang Poi School
Ms. Aree Kannika	Teacher of Ban Kong Khaek School

Note

STEAM Design Process

Learning in today's world has changed a lot over the last decade amid social complexity in all dimensions. Due to modern technology that has made education management more convenient and accessible, learning to adapt (especially by those in educational circles who have to take a new role and change their thinking process in learning management) is doubly important. A "teacher" is no longer the one-way knowledge provider, and school or learning units will become a common space for knowledge exchange between teachers and students through innovation, processes or new methods that are applied from textbooks, lessons, or personal experiences.