Do-It-Yourself Cognitive Science and Innovative Thinking Workshop

Faculty of Industrial Education

King Mongkut's Institute of Technology, Ladkrabang

Bangkok, Thailand

20 – 21 June, 2016

Workshop Report

Contents

Executive Summary

The Do-It-Yourself Cognitive Science and Innovative Thinking Workshop was initiated to generate greater interest among young Thai people in exploring science and to build a strong sense of scientific curiosity along with building hardware and carrying out experiments independently. The activities held at this Workshop sought to teach the participants about how the human brain works in a fun and hands-on environment through simple demonstrations and experiments, provide young people in Thailand with greater access to low cost resources to conduct experiments independently, empower students to facilitate their own educational experience, and learn how to become an innovator that can invent solutions that are valuable to the market and can benefit society.

This two-day Workshop was held on 20-21 June 2016 at the Faculty of Industrial Education at King Mongkut's Institute of Technology, Ladkrabang and brought in participants from five different universities across Thailand. The participants of this Workshop included 33 undergraduate and graduate students as well as university professors from King Mongkut's Institute of Technology Ladkrabang, Chulalongkorn University, Burapha University, Khon Kaen University, and Huachiew Chalermprakiet University. The Workshop was funded by the Open and Collaborative Science in Development Network (OCSDNet), the Center for Social Development Studies (CSDS) and was implemented by Piya Kerdlap and Teon Brooks in association with Fulbright Thailand, King Mongkut's Institute of Technology Ladkrabang , Burapha University, New York University, Open BCI, and the Innovation for Happiness Foundation.

At the Workshop, there were four different activities stations focused on teaching scientific theory and hardware construction for EEG (Electroencephalogram) and eye tracking to the participants. There were two separate activity stations for EEG and eye tracking, one for scientific theory and one for hardware building. The purpose of this format was to connect scientific theory with practice and experimentation. The scientific theory stations exposed the participants to the fundamental scientific knowledge about EEG and eye tracking which would prepare them for constructing their own EEG headsets and eye trackers. The hardware stations provided the participants with hands-on activities to build the equipment they learned about from the science stations. In the classroom, there were four separate tables set up for each of the activity stations. In the afternoon on both days, Bongkot Sewatarmra from the Innovation for Happiness Foundation facilitated an hour long session focused on teaching the participants how to think innovatively and understand what is needed to take a creative idea and turn into reality. Sewatarmra had the participants reflect on their experiences from working at the different stations through a series of questions and answers with the Workshop participants. Afterwards, she held a "marketplace of ideas" where all the participants had to propose inventions that would solve problems in Thailand and have to pitch these ideas to their peers in the room who were "investors."

The Workshop achieved various positive outcomes in terms of technical knowledge about cognitive science, innovative thinking, and greater exposure to DIY approaches to science, technology, and education. The participants gained exposure about EEG and eye tracking. In addition, the Workshop served as a technology capacity building activity for students and professors at the College of Research Methodology and Cognitive Science at Burapha University who regularly conduct research in cognitive science. These participants benefitted from learning how to construct low cost EEG and eye tracking

equipment and use them in regular experiments. The participants were able bridge the gap between theory and practice of EEG and eye tracking from rotating through the different activity stations. By working at the scientific theory and equipment building stations, the participants were able to see how knowledge and experiences in the scientific theory station were important for the equipment building station and vice versa. Another unique outcome of this Workshop was that the professors and students worked cooperatively during the activities, specifically in the equipment building stations, an element that does not often show itself in conventional education in Thailand. What helped enable this was that some of the professors did not have any background knowledge on building the low-cost EEG headsets or eye trackers which therefore put them on a level playing field with the students in learning how to build the equipment.

Through a Workshop survey, the participants expressed that their overall impression of the Workshop was either very good (42% of respondents) or good (58% of respondents). In terms of the individual activity stations, at least 85% of the respondents expressed that the EEG and eye tracking activities at the Workshop were either very good or good. Additionally, 96% of the respondents expressed that the sessions on innovative thinking were either very good or good. Many of the participants also expressed that they benefited from learning new ideas in general and being able to share ideas with the other participants from different universities. The Workshop also benefited the participants in that it allowed them to carry out equipment construction and dismantling with their own two hands and do something that was real and practical.

There were several success factors that led to the outcomes of the Workshop. Scientific theory and practice were built in together in the Workshop overall which gave the students a holistic and interactive approach in comparison to traditional lecture-style learning settings. They were able to be hands-on with their instructors while also discussing among their groups to gain new insights. Realistic and flexible objectives were established during the design and planning phase of the Workshop which helped reduce pressure for the participants and allowed them to simply explore cognitive science and DIY approaches and enjoy the experience. Having native Thai speakers with strong technical backgrounds in EEG, eye tracking, and fluent in Thai was critical to the success of the Workshop and removed communication issues. The sessions focused on innovative thinking were an important feature of this Workshop as they helped the participants think more conceptually, and see how their experiences at the Workshop could be applied directly in other areas of interest.

The Workshop Team would like to strongly thank all the organizations who invested their time, money, and resources in making this Workshop happen and for helping to create a positive impact for the future of education in Thailand.

Overview

On Monday and Tuesday 20-21 June, 2016, Piya Kerdlap, Teon Brooks, and Fulbright Thailand, here forth referred to as the Workshop Team, held a Do-It-Yourself Cognitive Science and Innovative Thinking Workshop at the Faculty of Industrial Education, King Mongkut's Institute of Technology, Ladkrabang (KMITL), Bangkok, Thailand. The Workshop brought in participants from five different universities in Thailand, which include King Mongkut's Institute of Technology Ladkrabang (KMITL), Chulalongkorn University (CU), Burapha University (BU), Khon Kaen University (KKU), and Huachiew Chalermprakiet University (HCU). This Workshop was carried out in association with the Open and Collaborative Science in Development Network (OCSDNet), the Center for Social Development Studies (CSDS), Fulbright Thailand, New York University, Open BCI, and the Innovation for Happiness Foundation.

The Workshop focused on teaching both undergraduate and graduate students, as well as university professors about how the human brain works in a fun and hands-on environment through scientific discussions and equipment construction and testing. During the Workshop, the participants were taught to build low-cost, open-source electronics, an eye tracker and EEG (electroencephalogram), for carrying out experiments in cognitive science. This Workshop helped the participants explore how these electronics can be used for conducting cognitive science experiments and learn new ways of thinking and learning. During the afternoon on both days of the Workshop, the Workshop attendees participated in a session on innovative thinking titled "Living Possibilities with an Innovator's Mind." Bongkot Sewatarmra from the Innovation for Happiness Foundation facilitated these sessions focused on teaching a practical approach to becoming innovators and thinking creatively. During these sessions, the participants were asked to reflect on their experiences at the different EEG and eye tracking activity stations looking at both the challenges and successes of learning new knowledge and building equipment from basic components and then using these experiences to help them understand what it takes to become innovators.

Workshop Objectives

The overarching objective for organizing this Workshop was to generate greater interest among young Thai people in exploring science and to build a strong sense of scientific curiosity and build hardware and carry out experiments independently. The Workshop sought to raise awareness among young people in Thailand about the educational resources available online and low cost methods for building equipment to carry out scientific experiments. This Workshop sought to achieve the overarching objective through activities that:

1. Teach participants about how the human brain works in a fun and hands-on environment through simple demonstrations and experiments
2. Provide young people in Thailand with greater access to low cost equipment and data resources to carry out experiments and conduct research independently
3. Empower students to carry out their own experiments and facilitate their own education in the sciences
4. Provide a process to think and create like an innovator and produce technology or programs that are valuable to the market and can benefit society

Another objective of the Workshop was to build technological capacity in the field of cognitive science in

Thailand, specifically in EEG and eye tracking. Based on discussions with researchers and professors at the College of Research Methodology and Cognitive Science at Burapha University, equipment to carry out EEG and eye tracking activities are currently very expensive in Thailand and therefore hard to acquire large amounts for everyone. One researcher spend 100,000 Thai Baht (~2,857 USD) to complete her research using EEG. As a result of the high price of the scientific equipment, the users have to be very careful with using the equipment so that it does not break or malfunction. One of the researchers had an opportunity to study cognitive science in Italy and noted that the researchers there use EEG and eye tracking equipment as if they were toys. To address this research technology need in Thailand, the Workshop was also designed to provide an introduction to low cost options for EEG and eye tracking equipment and train the participants, specifically the researchers and professors from Burapha University, on how to build low cost EEG headsets and eye trackers, how to use them, and where to acquire the parts and get technical support.

Planning and Execution

Piya Kerdlap and Teon Brooks led the Workshop Team with Fulbright Thailand as the major partner. Already based in Bangkok, Thailand, Piya was in charge of organizing the team and handling all scheduling, logistics, and communications for this Workshop. Teon Brooks served as the technical expert and led the design of technical content for the Workshop and training of the instructors for each activity station. Before the Workshop, Teon worked directly with all the activity station instructors in Thailand to teach them how to build the low cost EEG headsets and eye trackers and explained to the instructors working at the scientific theory stations what they would need to teach to the participants. Fulbright Thailand provided support in the design of the Workshop and also handled the process for inviting the participants from KMITL, CU, KKU, and HCU. In addition, Fulbright Thailand worked directly with a team of seven professors at KMITL that was responsible for all processes related to setting up the venue, logistics, catering, and facility support. There were 33 participants that participated in the Workshop with 17 males and 16 females.

Workshop Participants		
# Females	**# Males**	**# Total**
16	17	33

The estimated total cost of the Workshop was 55,194 THB and additional funds were not raised for this Workshop.

Workshop Activities

The Workshop featured four different activities stations focused on teaching scientific theory and hardware construction for EEG and eye tracking to the participants. There were two separate activity stations for EEG and eye tracking, one for scientific theory and one for hardware building. The purpose of this format was to connect scientific theory with practice and experimentation. The science stations exposed the participants to the fundamental scientific knowledge about EEG and eye tracking which would prepare them for constructing their own EEG headsets and eye trackers. The hardware stations provided the participants with hands-on activities to build the equipment they learned about from the science stations. In the classroom, there were four separate tables set up for each of the activity stations as shown in Figure 1 below.

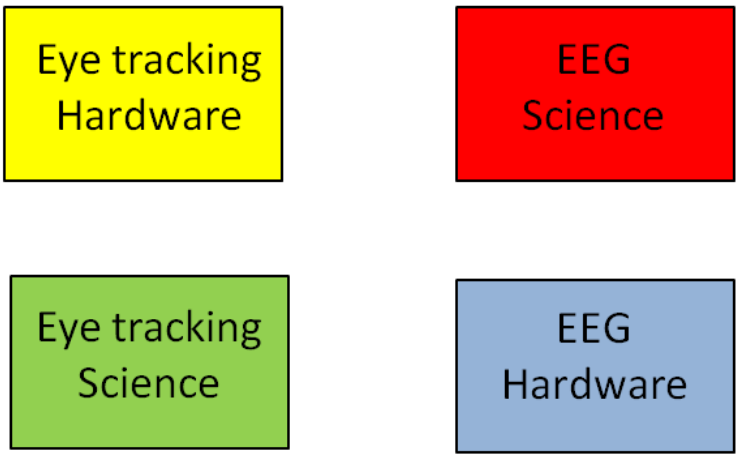

Figure 1: Layout of activity stations

The activity stations took place in morning and afternoon and lasted between 75-90 minutes each. Each day, the first activity session started at 10:15 am and the second session started at 1:00 pm. All the participants were divided into four groups of six to eight people for the entire Workshop and were then separated into the four different activity stations. Everyone would spend the day learning scientific theory and hardware for either EEG or eye tracking. Once a participant finished at one activity station, he/she would switch to the opposite focus, science or hardware, but stay in the same topic. For example, if someone started at the eye tracking hardware station in the morning on the first day, in the afternoon of that same day, that person would switch to the eye tracking science activity station. The purpose of this format for rotation is so that every participant would focus on either just EEG or eye tracking for the full day and learn both science and hardware. This order for rotation was set up in this manner so that the participants can see how the knowledge in the science activity is related and applicable to the hardware station and vice versa.

Figure 2: Table arrangements at Workshop

In the afternoon on both days, Bongkot Sewatarmra facilitated an hour long session focused on teaching the participants on how to think innovatively and understand what is needed to take a creative idea and turn into reality. Sewatarmra had the participants reflect on their experiences from working at the different stations through a series of questions and answers with the Workshop participants.

The following sections provide detailed descriptions of what happened at each activity station and the discussions that took place during the afternoon sessions about innovative thinking.

EEG Scientific Theory Station

This activity station focused on teaching the fundamentals of EEG to the participants. Professor Sarawin Thepsitthiporn, from the College of Research Methodology and Cognitive Science at Burapha University, served as the instructor for this activity station throughout the Workshop. Thepsitthiporn first explained basic scientific concepts and facts about the brain starting from the structure and components of the neuron and how the different components of the neuron interact with each other using different diagrams. He then progressed to discussing the larger components of the human brain such as the different lobes and where they are located. Thepsitthiporn then discussed the functions of each part of the brain. After reviewing the biological aspects of the brain, Thepsitthiporn discussed the different signals the human brain uses to communicate and how those signals can be measured with EEG technology. He discussed the areas on the head where electrodes should be placed to best track the signals in the brain. Further to this, Thepsitthiporn taught about how different waves appear during different types of human activities such as sleeping, running.

Figure 3: Professor Sarawin Thepsitthiporn teaching fundamentals of EEG

EEG Hardware Station

This activity station focused on teaching the participants how to build their own eye trackers. Professor Poliny Ung, from the College of Research Methodology and Cognitive Science at Burapha University, served as the instructor for this activity throughout the Workshop with supervision from Teon for general technical support. The EEG headsets were built from 3D-printable parts, gold-cup electrodes, dry Ag-AgCl electrodes, screws, nuts, and bolts. The participants were taught how to strip electrical wire to expose the leads needed to make dry electrode for easy recording. They attached the exposed wire to the dry electrode and bolted the connections down using nuts driven around a screw. The frame was glued together of the headset, and the new electrodes were mounted on the headset frame. These electrodes were installed in an open-source WEG micro controller that transmitted the data wirelessly to a USB dongle attached to a computer.

Figure 4: Professor Poliny Ung (right) demonstrating how to build the EEG headset

Figure 5: Teon Brooks (middle) explaining how to collect data with the low cost EEG headset

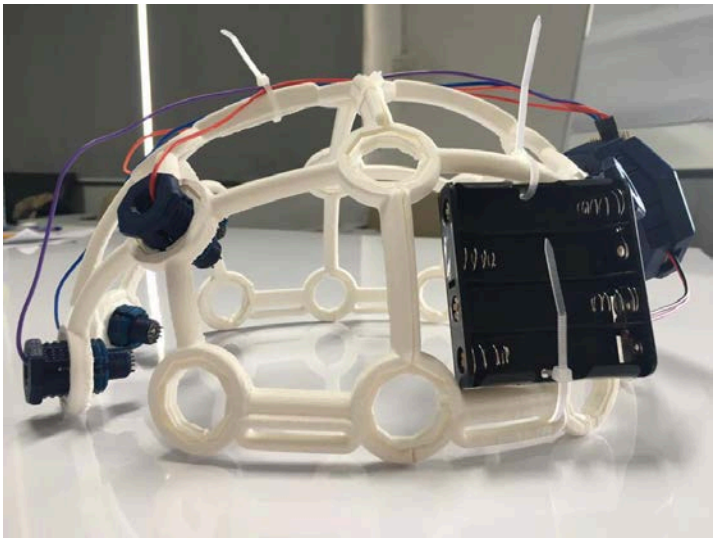

Figure 6: Constructed Open BCI EEG headset

Eye Tracking Scientific Theory Station

This activity station focused on teaching the fundamentals of eye tracking. Professor Inthraporn Aranyanak, from the College of Research Methodology and Cognitive Science at Burapha University, served as the instructor for this activity throughout the Workshop. Aranyanak first provided an introduction to the science of eye movement and how measurements have helped scientists uncover psychological processes that occur during tasks such as reading, visual searching, and scene perception. Then she taught the science behind eye tracking processes and the various tools used to measure the movements of the eye. Professor Aranyanak helped make this station interactive by asking the students to provide their own experiences about how they perceive different images and how they read text in different formats. Participants at this station were also able to watch videos about the different subtopics about eye tracking.

Figure 7: Professor Inthraporn Aranyanak (purple) teaching the fundamentals of eye tracking

Eye Tracking Hardware Station

This activity station focused on teaching the participants how to build their own eye trackers. Miss Sarah du Pont served as the instructor of this session throughout the Workshop with supervision from Teon Brooks for general technical support. An eye-tracker is a high-speed camera with very precise timing and image capture. Ranging from 100 frames per second to upwards 2000 frames per second, the camera takes images of the eye as its raw signal. After initiating a calibration routine, the data preprocessing pathway can begin, which enables the user to detect where the eye is by tracking the pupil. For the Workshop, off-the-shelf equipment were taken: a PS3 webcam, IR LEDs, resistors, batteries, wire ties, gauged wire, and sunglasses, and built a head-mounted eyetracker. The participants learned how to make an IR illuminator by building a circuit with the batteries, a resistor, and IR LEDs. In addition, they learned to modify an IR-blocking, visible light sensitive camera to make an IR-sensitive, visible light-blocking camera. Once these components were fabricated, they were mounted to a modded pair of sunglasses. This enabled the creation a head-mounted eyetracker for a fraction of the cost.

Figure 8: Sarah du Pont (right of easel) teaching how to build eye tracker

Figure 9: Teon Brooks (middle) explaining how to connect eye trackers to computer to collect data

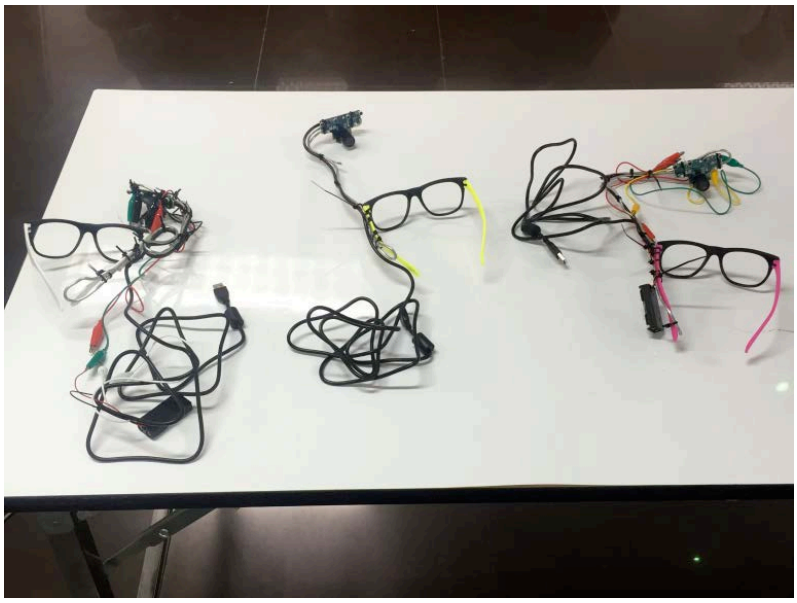

Figure 10: Completed DIY eye trackers

Innovative Thinking Sessions

These sessions titled “Living Possibilities with an Innovator's Mind” focused on teaching the participants on how to think more innovatively and create with a purpose. Bongkot Sewatarmra from the Innovation for Happiness Foundation was the instructor for these sessions on both days. In the morning on the first day of the Workshop before the start of the activities, Sewatarmra asked the students to answer a set of questions to get them to express their initial understanding and perception of EEG and eye tracking about how to build the equipment based on their own knowledge or guessing, and the level of confidence to build the equipment from scratch. These questions included:

1. What is an electroencephalogram (EEG)?
2. What is an eye tracker?
3. Who uses an EEG or eye tracker?
4. What is the first step in building an EEG and eye tracker?
5. Am I confident in building an EEG and eye tracker on my own?

In the afternoon on the first day of the Workshop, the participants were asked to revisit the questions they answered in the morning. They first started to discuss what they had learned during the first day of the Workshop. The participants were first asked to state the hardest activity station they spent time at and list five different tasks that were hard. Then, the participants were asked to decide which activity station was the easiest for them. Sewatarmra then asked the participants if it was harder for them to learn scientific theory or build the equipment at either the EEG or eye tracking stations. Afterwards, the participants were asked about the difference in outcome of their activities during the day between being told what to do step by step versus being told a goal that needed to be achieved.

Figure 11: Bongkot Sewatarmra (with microphone) asking the participants about their initial perceptions of DIY before the start of the Workshop

Later, Sewatarmra began teaching about innovators, provided examples of individuals such as Albert Einstein and Steve Jobs, and then asked the participants to name some innovators they know and discuss the inventions those innovators created. She then proceeded to teach about the difference between being creative and imaginative. She explained how in Thailand, people think being imaginative means having a big fantasy or make-believe picture and think this is the same as being creative. This is because in Thailand, people often think that being imaginative and creative have the same meaning. Sewatarmra then discussed how innovators think and the manner in which they positively approach failure in the overall process for them to achieve their goals and objectives in their creation. At the end of the session, the participants were given an assignment to come up with an invention that would solve an issue for people in Thailand and to think carefully about if this invention exists already, the demand for the invention, and the benefits it offers to society. These proposed inventions from the participants would be discussed in the afternoon on the second day of the Workshop.

Figure 12: Bongkot Sewatarmra (left) discussing with the participants their experiences with building their own eye trackers and EEG headsets for the first time

During the next session on innovative thinking on the second day of the Workshop, Sewatarmra asked the participants to briefly discuss the inventions they came up with and share their ideas with the other people at the table. She then proceeded to teach about different learning approaches to learning that innovators employ to be successful, which include problem-based and project-based learning.

Afterwards, Sewatarmra presented examples of local innovators in Thailand who she has worked closely with through her Foundation. These innovators were not geniuses or very wealthy, but they had an idea that they dedicated their time and efforts to and were successful because they applied the principles of problem-based and project-based learning. The participants were impressed with the inventions that were created by these local innovators in Thailand who had limited funds and resources to create their product, yet they were very successful.

The last activity in the innovative thinking session was a marketplace of ideas. All four tables had an easel with flipchart paper and all the participants had to list their inventions. Each participant at the table had three stickers that they would place under the idea they would support or "invest" in. After all the votes were made, Sewatarmra invited the participant who's idea had the most votes to come to the front of the room and present his/her idea. At some tables, the participant who's invention had the least votes come to the front of the room and present his/her idea instead. Sewatarmra expressed that often times, the invention or idea may have received the most votes because it was not useful, but because it was not pitched or marketed in the right way. This was therefore an opportunity for the participant who's invention did not receive the most votes to get some coaching in how to present and idea and make it intriguing for an investor. After each person from the four tables presented their ideas to the whole classroom, Sewatarmra listed the inventions from all four tables that received the most votes and all the participants had to vote on one invention that they would invest in.

Figure 13: Bongkot Sewatarmra explaining how Einstein was an innovator

Figure 14: Participants exchanging ideas about their proposed inventions

Figure 15: Participants discussing ideas to invest in

Figure 16: Bongkot Sewatarmra (middle) coaching a participant on how to pitch an idea to an investor

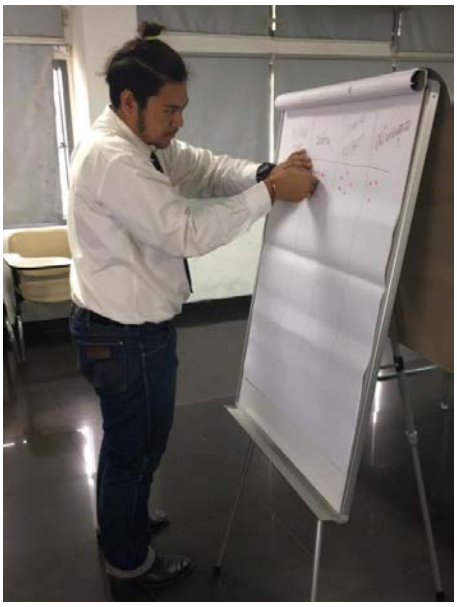

Figure 17: Participant making his vote in the final round of the marketplace of ideas

After this interactive activity among the participants, Sewatarmra closed the session by teaching about the process of how innovators think and a model for thinking called GROWME which stands for:

- G-Goal
- R-Reality
- O-Options
- W-Willingness/Work
- M-Monitoring
- E-Evaluation

Workshop Outcomes

Achievements

The Workshop achieved various positive outcomes in terms of technical knowledge about cognitive science, innovative thinking, and greater exposure to DIY approaches to science, technology, and education. In terms of cognitive science, the participants gained exposure about EEG and eye tracking. A majority of the participants at the Workshop did not have a background in psychology or cognitive science, but had expressed that they enjoyed learning about a new topic in a fun an interactive manner. In addition to providing basic knowledge in cognitive science, this Workshop also served as a technology capacity building activity for construction and experimentation of low cost EEG and eye tracking equipment, specifically for the participants from the College of Research Methodology and Cognitive Science at Burapha University as previously discussed in the previous section on Workshop Objectives. These participants attended this Workshop to specifically learn more about how EEG and eye tracking experiments can be carried out using equipment that is easy to construct and is less costly than what currently exists in the market.

One of most important achievements was that the Workshop provided an enabling environment for the participants and the instructors to try new approaches to teaching and learning. The participants were able bridge the gap between theory and practice of EEG and eye tracking from rotating through the different activity stations. Using this arrangement of activities, the participants were able to see how knowledge and experiences in the scientific theory station was important for the equipment building station and vice versa. Participants were also able to take a learning-by-doing approach to understanding EEG and eye tracking. At the equipment stations, the participants were able to learn about EEG headset and eye tracking technology not just by reading about it or studying a diagram, but by building and breaking apart the components of the technology. Building and breaking apart the components of the equipment was a new experience for the participants based on observations at the eye tracking station. At this station, many of the participants were hesitant to break apart the web-cameras as they were concerned about breaking expensive materials. However, after being told that the cameras were $5 each and were inexpensive, the participants had fewer concerns about breaking apart the cameras. The instructors also motivated the participants to use any means necessary to break apart the cameras and remove the lens, which helped the participants feel more confident about breaking down materials. Understanding some of the concerns regarding breaking apart the cameras was valuable since this step is one of the first barriers that need to be overcome when it comes to DIY approaches in science. In contrast to the eye tracking station, the participants at the EEG headset building station had fewer concerns about doing the activities. They felt more confident building the low-cost headset since it did not involve breaking it apart or being penalized for damaging equipment.

One of the other unique outcomes of this Workshop was that the professors and students worked cooperatively during the activities, specifically in the equipment building stations. It is very typical in Thailand's education system for knowledge to flow from teacher to student and not the other way around because Thai society has traditionally emphasized the level of importance of a teacher and in some cases, it is taught that teachers are always correct and know better than the student. This

Workshop was an opportunity to disrupt this conventional standard and have the students and professors work together and learn from each other at the activity stations. At the equipment building stations, the Workshop team observed that the students and professors helped each other build the equipment from scratch. What helped enable this was that some of the professors did not have any background knowledge on building the low-cost EEG headsets or eye trackers which therefore put them on a level playing field with the students in learning how to build the equipment. This was a new experience as expressed by one of the bachelor degree student participants from Chulalongkorn University. During one of the Workshop breaks, the student was casually asked in private about how he felt working with professors and graduate students at the same table to cooperate during an activity. The student expressed that he felt weird at first since this type of arrangement is not common in educational settings in Thailand, but after some time the student got used to this type of arrangement and enjoyed cooperating with the professors and sharing ideas.

Feedback from Participants

On the last day of the Workshop, the participants were asked to answer a survey to provide feedback on their experience at this two-day Workshop. Out of 33 participants, there were 26 survey respondents. About 60% (3 out of 5 people) of the participants were between 18 to 25 years old while the rest of the participants were between 26 to 50 years old as shown in Figure 18 below.

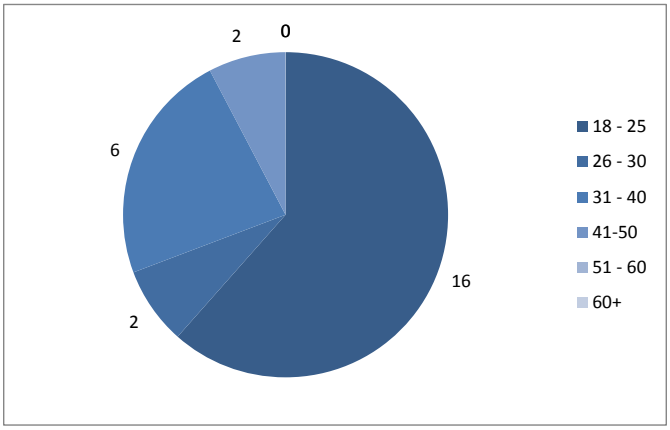

Figure 18: Age group of Workshop participants

The participants came from different academic levels with 60% (3 out of 5 people) of participants as bachelor degree students while the rest of the participants were either PhD students or university professors as shown in Figure 19 below.

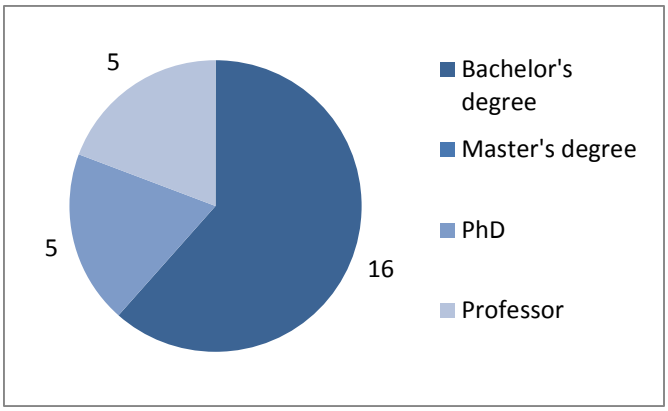

Figure 19: Academic level of Workshop participants

All 26 survey respondents expressed that their overall impression of the Workshop was either very good (42%) or good (58%). In terms of the individual activity stations, at least 85% of the respondents expressed that the EEG and eye tracking activities were either very good or good at the Workshop. Additionally, 96% of the respondents expressed that the sessions on innovative thinking were either very good or good. This information is illustrated in Figure 20 below.

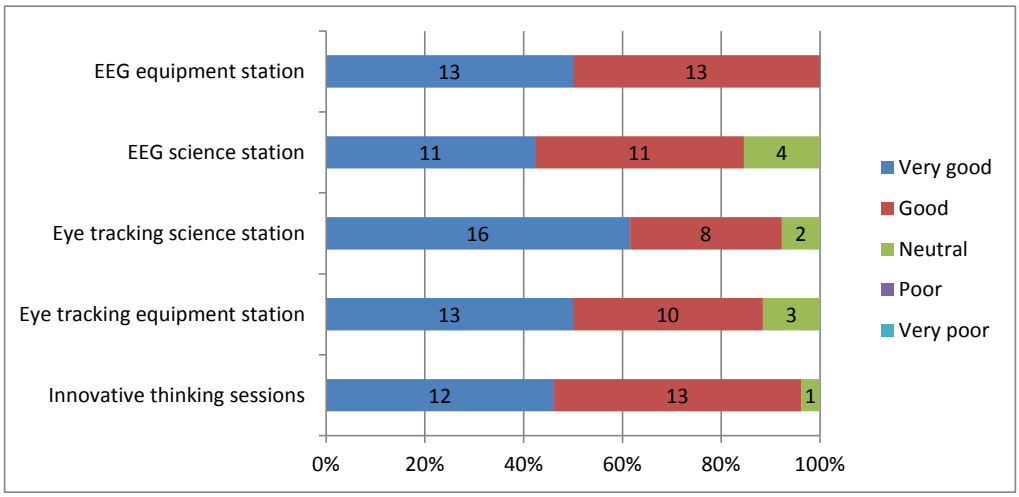

Figure 20: Level of participants' satisfaction with Workshop activities

In the survey, the participants were also asked the following open-ended questions:

1. What benefit do you think you gained from this Workshop?
2. What did you like the most about this Workshop?
3. How would you improve this Workshop?
4. If you had another chance, would you attend this type of Workshop again or not? Why?

"What benefit do you think you gained from this Workshop?"

Several of the participants expressed that the benefits they gain was knowledge and experience in the field of cognitive psychology and learning how to build an EEG headset and eye tracker. They enjoyed learning about these topics in a very easy process. Many of the participants also expressed that they benefited from learning new ideas in general and being able to share ideas with the other participants from different universities. The Workshop also benefited the participants in that it allowed them to carry out equipment construction and dismantling with their own two hands and do something that was real and practical. According to the participants, one of the other important benefits of this Workshop was that they learned about how innovators think and how they could apply the thinking approach they learned to the work they currently do.

"What did you like the most about this Workshop?"

One aspect that the participants liked the most about the Workshop was the quality of instructors at the different activity stations. The participants expressed that the team of instructors taught in a very easy manner and the participants did not have a hard time learning a completely new topic. Although the participants did not have a background in the topics that were taught, they were still able to understand the content and conduct the activities because of the effective manner of instruction provided. This helped make each of the activity stations interesting. Participants also liked how they were able to do hands-on activities such as taking apart the components of the camera for the eye tracker and building the parts of the EEG headset. This was something new and interesting to the participants and they enjoyed getting to practice building the equipment independently with some guidance from the instructors and some support from their peers at the table. The participants also liked working in a team setting at the activity stations and cooperating with other people at the table from different universities in Thailand.

"How would you improve this Workshop?"

There were mixed views among the respondents regarding the length of time for each activity station. Some preferred to have more time to conduct the activities while others expressed that some stations had lots of time left over after the activity was completed. The issue of too much time most likely occurred in the scientific theory stations as the instructors did have an hour to an hour and a half to teach the scientific fundaments of EEG and eye tracking. In the future, it would be better to have more hands-on activities integrated into the scientific theory activity stations as well and reduce some of the content on scientific theory. One participant expressed a need for more equipment to be available to work and experiment with during the Workshop. Another participant requested that this Workshop be upgraded into a full sleepover camp where participants could do even more of these types of hand-on DIY activities.

If you had another chance, would you attend this type of Workshop again or not? Why?

All the survey respondents expressed that they would attend this type of Workshop again if there was another opportunity. The main reasons for wanting to attend this sort of Workshop again include gaining new knowledge and experiences, learning about how to think to create innovative products, and the Workshop's environment that allowed for open and creative learning. Participants also expressed that they would attend this type of Workshop again to learn new teaching approaches that could be applied in practice. The participants were satisfied with their experience in doing these scientific activities independently and would attend this type of Workshop again because of their positive experiences.

Lessons Learned and Recommendations for Future DIY Workshops in Thailand

There were several factors that contributed to the successful outcomes of the Workshop.

1. **Build together theory and practice in the Workshop overall.** The hands-on equipment building activities were met with equally informative theory-based sessions. Each of the hardware technologies that were built had a research-focused discussion session of how the technology worked and how it is used in cognitive science research. This gave the students a holistic and interactive approach to traditional lecture-style learning settings. They were hands-on with their instructors while also discussing among their groups to gain new insights. As demonstrated in the survey responses, the participants enjoyed being able to learn theory and practice at the same time and see the connection between the two dimensions.

2. **Establish realistic and flexible objectives.** During the design phase of the Workshop, it was intended to not have a strict agenda with concrete outcomes for each station. The general goal was to provide exposure to cognitive science, DIY science, and have the participants explore the equipment available to them. The result of this overall approach was greater flexibility in the activities at each station and reduced pressure for the participants which allowed them to simply enjoy the experience. The participants had objectives and steps explained at the start of each equipment building station, but they were by no means mandated to achieve the objective in a set period of time or submit something concrete at the end of the activity.

3. **Employ local subject matter experts as Workshop instructors as a standard.** Having native Thai speakers with strong technical backgrounds in EEG, eye tracking, and cognitive science in general was critical to the success of the Workshop. This arrangement avoided communication issues that would have occurred had the Workshop instructors been international experts who can not communicate in Thai fluently and are therefore limited in their ability to transfer knowledge. This does not by any means devalue the role or contributions to a DIY Workshop of an international expert that is unable to communicate in Thai or any local language in Southeast Asia. The international expert would be best suited to serve in a more advisory role that is available to help the local instructors carry out the demonstration activities and address any technical issues or challenges. This approach was taken during this Workshop where Teon Brooks provided technical support to the instructors at the equipment construction stations and helped answer any questions or address any issues.

4. **Integrating a non-technical session focused on innovative thinking.** The sessions about innovative thinking were an important feature of this Workshop because it helped the participants think more conceptually, but still have some focus on the core activities of the Workshop, which in this case was EEG and eye tracking. The innovative thinking sessions took the content of the Workshop to a higher level and helped the students see how the knowledge and experiences they gained in each of their activities stations can be applied beyond cognitive science and can also be applied in other areas of interest.

There are also several aspects of this Workshop that could be improved upon to help make future DIY Workshops in Thailand even more successful.

1. **Avoid activity stations focused strictly on scientific theory.** Having theory and practice as complete separate stations resulted in some challenges, such as some stations not having enough time to conduct the activities while some stations had too much time. Also, some participants expressed that although the knowledge they gained at the scientific theory stations was valuable, there were not enough hands-on activities and some participants started to lose interest in the topics being taught towards the end of the scientific theory stations. Thus, it would be beneficial for sessions with a focus on scientific theory to include some real equipment for the participants to try and use and experiment with to provide a hands-on element to these stations.

2. **Design a side activity for intermittent participation.** During the Workshop, there were times where the participants finished their activities at their station earlier than planned and had a good amount of free time and were not sure what to do while the other activity stations were still active. To alleviate this, it is recommended that a side activity be set up outside of the main activity stations that the Workshop participants can engage with in their free time during the Workshop. This proposed side event should preferably not have a schedule and instead be open and available at all times during the day to allow participants to take part intermittently. A simple option would be to create a board with lists of different subtopics directly related to the theme of the Workshop. Here, people would be able to express their thoughts and opinions on a certain topic that they may not have been able to discuss at their previous activity stations and work overall.

3. **Provide supplementary materials and instructions with follow up activities.** At the end of the Workshop, almost half of the participants were interested in learning more about DIY science and innovative thinking after having spent two full days focused at the DIY Workshop. Unfortunately, the Workshop team did not have supplementary materials available to the eager and curious participants. For future Workshops, it is recommended that a set of supplementary materials are created in advance to be provided to the participants at the end of the Workshop. A set of follow up activities for the participants to carry out that are directly related to the key topics of the Workshop would be useful. It is essential to provide the participants with more content at the end of the Workshop when the excitement is still fresh and are eager to continue learning.

Special Pictures from the Workshop

Figure 21: Team picture with participants from the College of Research Methodology and Cognitive Science, Burapha University

Figure 22: Workshop Team (left to right): Chotima Chaitiamwong, Fulbright Thailand; Bongkot Sewatarmra, Innovation for Happiness Foundation; Piya Kerdlap; Benjawan Ubonsri, Fulbright Thailand; Assoc. Prof. Dr. Kitipong Mano, KMITL, Teon Brooks, NYU; Sarah du Pont

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