SCIENCE MAGAZINE

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SEAQIS Programme

Training on Digital Technology Application in Science Learning for Elementary Teachers in Bogor Regency

Science Fact

Amazon Rainforest Facts with disappearing

Events

Seminar on STEM and Robotics

STEM EDUCATION USING DRONES IN SCHOOL

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STEM LEARNING

COMPUTATIONAL THINKING

REGIONAL OFFICE of CLIMATE EDUCATION (R-OCE)

SEAQIS GLOBAL PROJECT on MAKING STEM SOCIALLY RELEVANT

SEAMEO

QITEP IN SCIENCE

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Dear readers,

Welcome to the second edition of our Q Science Magazine. This edition is more compact than the previous one where you can find information about our latest training programme in Bogor. There is also news about our events conducted between December 2019 and March 2020, i.e. Seminar on STEM and Robotics towards the Industrial Revolution 4.0 and Society 5.0, Workshop on STEM Education: Using Drones in Schools, In-House Training on Computer Science Education: Integrating Computational Thinking into Science Learning, and SEAMEO – University of Tsukuba Symposium. Besides, there are short articles at the Science Fact section, a movie review, and research papers from SEAQIS Research Grants programmes. From the alumni, there is a report of Computational Thinking implementation. Last but not least, in SEAQIS Corner, we introduce you to our new Deputy Director for Programme. Considering the current situation, on behalf of the Centre, I would like to share our heartfelt support and solidarity with you and your families. I do hope this pandemic soon will be contained and we all are granted salvation.

Thank you very much and have a pleasant read.

Dr Indrawati
Director

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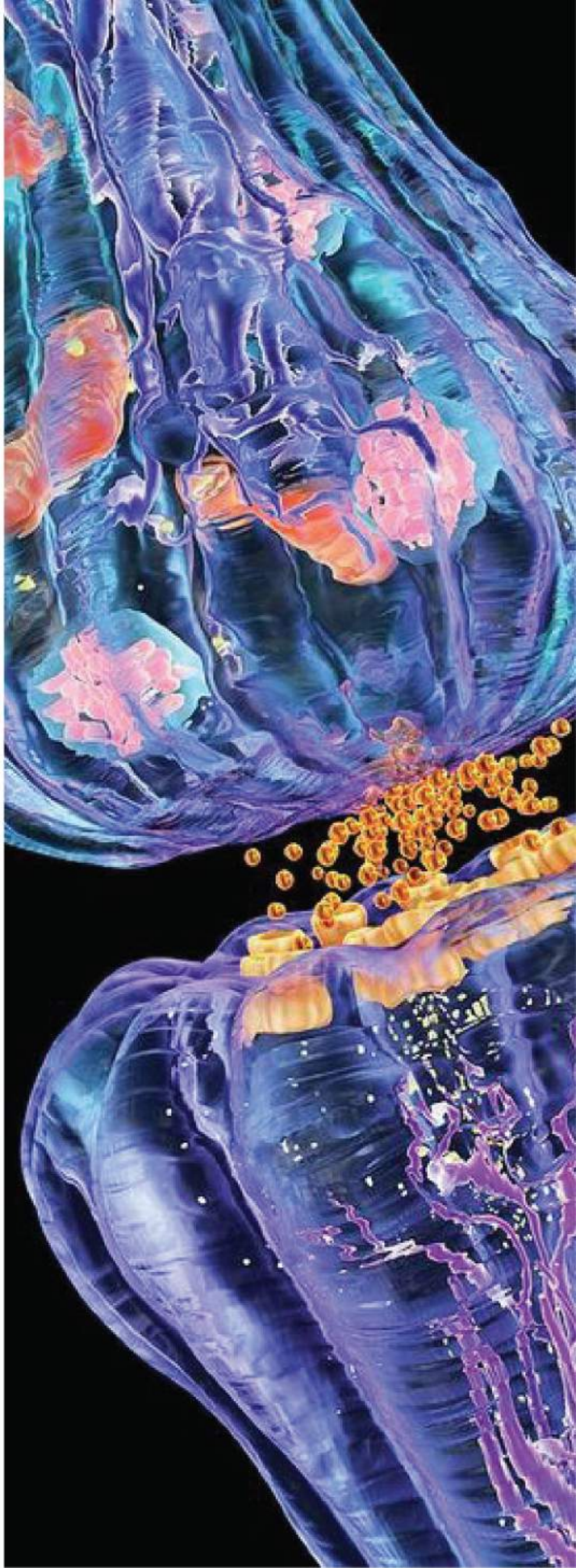


THE 3RD KI HAJAR DEWANTARA AWARD

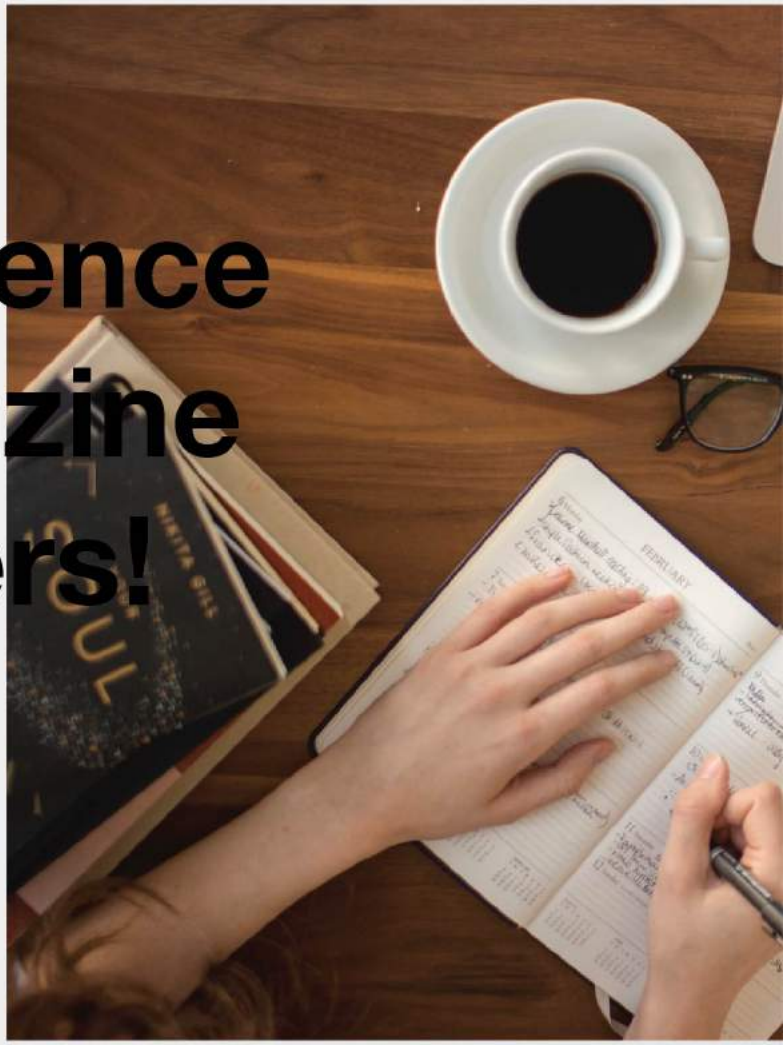
17 NOV 2020

YOGYAKARTA, INDONESIA

Registration

http://s.id/KHD20

Hello Q Science Magazine readers!



Editor Message

partnership.qitepinscience.org

Welcome to our second edition of Q Science Magazine. Firstly, we would like to express our gratitude to God Almighty upon the publishing of this second edition. Secondly, we also would give our high appreciation to our editorial staff and contributors who had worked so hard in making this magazine.

Mistakes and errors in this publication might exist therefore critics, comments, and suggestions are very much welcome as they will help us improve the next edition. In this edition, we bring new section, SEAQIS Corner. It tells more personal stories about SEAQIS' staff.

We hope this magazine provides you with a new information regarding the current issues in science.

Thank you very much and have a good read.

Training on Digital Technology Application in Science Learning for Elementary Teachers in Bogor Regency

A participant put on the Virtual Reality headset

the participants tried to install the applications in their laptop and mobile phones

The existing Industrial Revolution 4.0 has had a significant impact on the latest technological advances in the fields of Cloud Computing, Artificial Intelligence, IoT (Internet of Things), 5G technology, various digitalization, and Big Data. These are all potentials for the world of education. This causes the narrowing and fusion of the factors "space and time" which have been the aspect of determining the speed and success of mastery of science by humanity. These technological advances can be used as "tools for working" in learning. Someone must have and master the tools to work. Mastery of Information and Communications Technology (ICT) and information literacy is an obligation.

SEAMEO QITEP in Science (SEAQIS) as a technical unit focusing on carrying out the development and empowerment of science teachers and education personnel in Southeast Asia, has developed innovative programmes that support the acceleration of ICT mastery and information literacy of science teachers and education personnel. One of the programmes is training on digital technology application in science learning.

Mr Rizwan Darmawan exposed the profile of the Centre

In collaboration with the Education Office of Bogor Regency, SEAQIS conducted Training on Digital Technology Application in Science Learning for Elementary School Teacher at Rizen Premier Hotel from 13 to 15 February 2020 for the first batch, and from 17 – 19 February for the second batch. The participants were 225 elementary school teachers for each batch. The training was aimed at introducing digital technology applications to elementary school teachers that can be used in teaching science. The topics discussed during the training were trends and issues in science learning in the era of industrial revolution 4.0, the importance of digital technology, Augmented and Virtual Realities, PhET, and various online assessment applications such as Kahoot and Google Form.

The facilitators of the training for the first batch were Dr Indrawati, Dr Poppy Kamalia Devi, Ms Lili Indarti, Mr Zuhe Safitra, Mr Heri Setiadi, Mr Dian Purnama, Mr Prima Dermawan, and Mr Yudi Yanuar. For the second batch, the facilitators were Dr Poppy Kamalia Devi, Mr Rizwan Darmawan, Mr Lukman Nurhakim, Mr Septian Karyana, Mr Gunawan Muhammad, and Ms Lintang Ratri Prastika. The training was officially opened by Mr Yadi Mulyadi, the secretary of the Education Office.

During the training, the participants showed their enthusiasm, especially when using digital applications. They then commented that they would implement it in their class to make teaching-learning more interesting even though the internet connection in their area is still a major problem. Besides, the specification of the gadget needed for the application is also another problem. At the end of the training, all participants agreed that this kind of training is very useful moreover as a teacher, they have to update their skills and follow the trends.

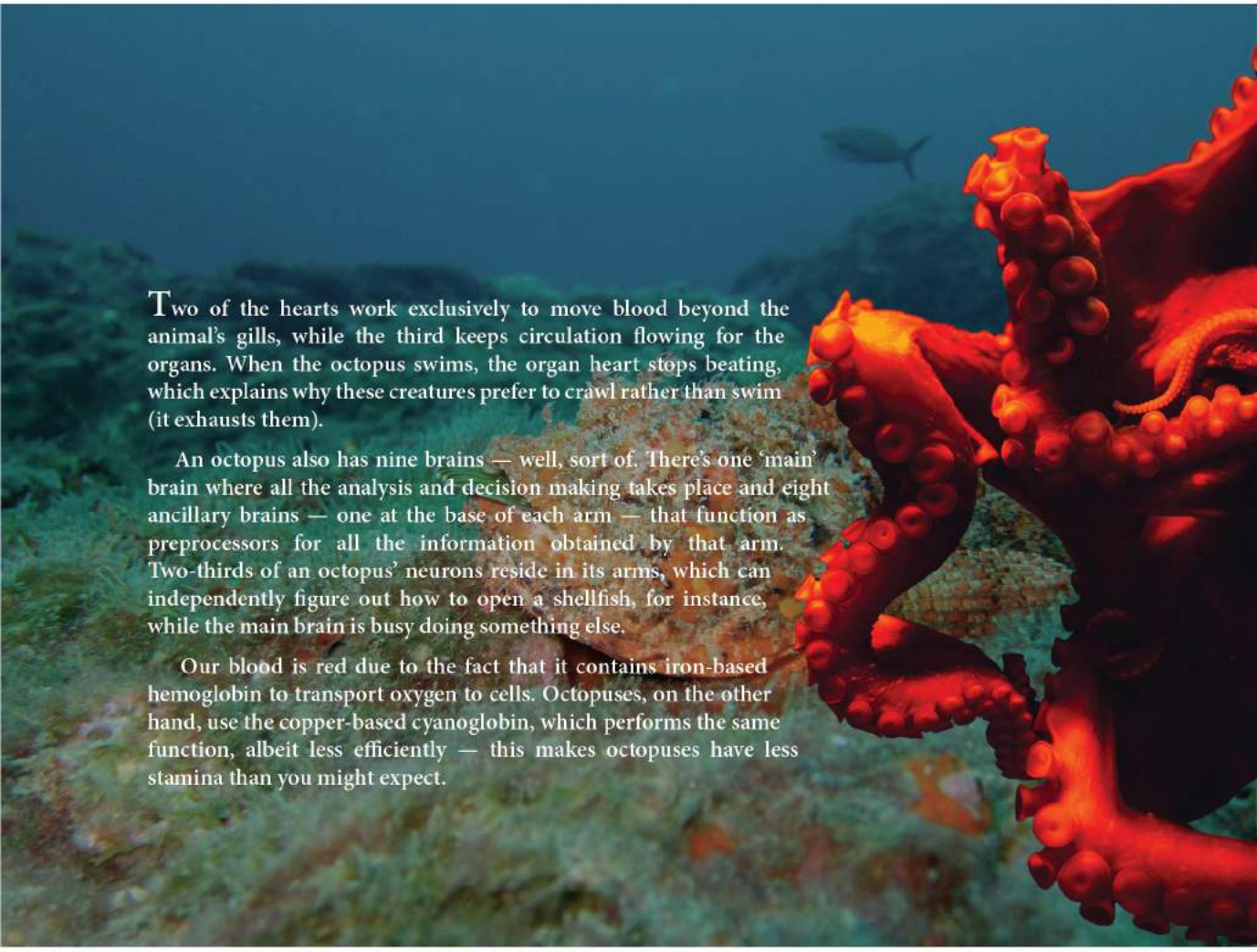
3. 20% of Earth's oxygen is produced by the Amazon rainforest

Source: https://www.howitworksdaily.com/15-amazing-science-facts-that-will-blow-your-mind/

Our atmosphere is made up of roughly 78 per cent nitrogen and 21 per cent oxygen, with various other gases present in small amounts. The vast majority of living organisms on Earth need oxygen to survive, converting it into carbon dioxide as they breathe. Thankfully, plants continually replenish our planet's oxygen levels through photosynthesis. During this process, carbon dioxide and water are converted into energy, releasing oxygen as a by-product. Covering 5.5 million square kilometres (2.1 million square miles), the Amazon rainforest cycles a significant proportion of the Earth's oxygen, absorbing large quantities of carbon dioxide at the same time.

Octopuses have three hearts, nine brains, and blue blood

Source: https://nationalpost.com/pmn/news-pmn/9-brains-3-hearts-some-wild-facts-about-octopuses



Two of the hearts work exclusively to move blood beyond the animal's gills, while the third keeps circulation flowing for the organs. When the octopus swims, the organ heart stops beating, which explains why these creatures prefer to crawl rather than swim (it exhausts them).

An octopus also has nine brains — well, sort of. There's one 'main' brain where all the analysis and decision making takes place and eight ancillary brains — one at the base of each arm — that function as preprocessors for all the information obtained by that arm. Two-thirds of an octopus' neurons reside in its arms, which can independently figure out how to open a shellfish, for instance, while the main brain is busy doing something else.

Our blood is red due to the fact that it contains iron-based hemoglobin to transport oxygen to cells. Octopuses, on the other hand, use the copper-based cyanoglobin, which performs the same function, albeit less efficiently — this makes octopuses have less stamina than you might expect.

Maglev Train

Source: https://science.howstuffworks.com/transport/engines-equipment/maglev-train.htm

Magnetic levitation is a method for making an object float in the air with a magnetic field. This field is used to reject or negate the gravitational pull. This is used by the Maglev train transportation mode. This maglev train hovers around 10 cm -15 cm above the tracks. This causes no friction between the rail and the train which can hamper the movement of the train so that the train can go quickly to reach 500km / hour (310 mph). The work system of Magnetic Levitation Train utilizes two magnetic principles, namely magnetic attraction and magnetic repulsion. There are two working systems of the maglev train so that it can float or float on the rails namely Electromagnetic Suspension (EMS) and Electrodinamic Suspension (EDS).

SEMINAR ON STEM AND ROBOTICS TOWARDS THE INDUSTRIAL REVOLUTION 4.0 AND SOCIETY 5.0

Opening remarks by CDETEP in Science Director

Robotics is a combination of science in the fields of electronics, machinery, mechanics, and computer software. At this time, robotics is not only taught to students in higher education but also introduced to students in primary and secondary education. This kind of technological education generally carried out by the robotics community, considering that it has not been discussed in formal education nor has it been nationally standardized. However, robotics now has become a demand in the era of industrial revolution 4.0 which is in the middle of the 5.0 society.

The industrial revolution 4.0 is an era where the automation of industrial machines based on artificial intelligence started to be used in the industrial world. This encourages the production of smart robots that will replace human labour in the company. This technological developments certainly need to be adapted and followed by quality human resources improvement, which has added value (Society 5.0) and is equipped with qualified technological knowledge. One of the strategies to improve the quality of human resources in facing the industrial era 4.0 is through robotics technology education.

Closing remarks by the SEAQIS Director

Presentation of Learning Analytics by Dr. Hayashi Yusuke

To address the latest issues regarding the industrial revolution 4.0 and community 5.0, SEAQIS, in collaboration with the Asosiasi Robotika untuk Edukasi Indonesia (AREI) held a two-day seminar on STEM and Robotics. AREI is an association of robotics communities whose activities focuses on educational robots. This association consists of academics and robotics practitioners who are professional and experienced in the field of robotics, which currently has more than 10 robotics communities.

This seminar was held on November 22-23 2019 and was attended by 250 participants consisting of teachers, principals, students, instructors, and other stakeholders. The event was officially opened by the Director of CDETEP in Science, Mr Enang Ahmadi. The STEM and Robotic seminar also presented four main speakers namely Dr Totok Suprayitno, the Head of Research and Development Agency of the Ministry of Education and Culture, Dr Gatot Hari Priowirjanto, the Coordinator of the SEAMEO Centres Indonesia, Dr Sediono Abdullah, Learning Technology Developer of Pustekkom, and Dr Hayashi Yusuke of Hiroshima University. Besides, there were also other presenters presenting their research reports in STEM education and also a talk show about robotics for education in Indonesia.

During the seminar, there was an exhibition of robotics for education. In addition, students from SEAMEO School displayed their works. For this STEM and Robotic seminar, SEAQIS hopes that the seminar will bring benefits to the participants and robotics can be one of the media to support STEM learning.

WORKSHOP ON STEM EDUCATION: USING DRONES IN SCHOOLS

Drones have become part of technological developments in the 21st century that have important roles in several fields, starting from its functions for photo and videography activities, geospatial mapping, delivery of goods, to military applications.

With the widespread use of the drone, SEAQIS collaborated with SHEMAPS in conducting training using drones in schools. SHEMAPS is a company based in Australia engaged in the use of drone technology and has successfully integrated the learning of drones in the curriculum in Australia. On this occasion, SHEMAPS introduced how they utilize this technology in STEM learning in schools.

"Dr Karen Joyce helped the participants to use Geospatial Mapping Programme"

Dr Karen Joyce and Paul Mead taking a group photo with the participants

The training aimed to introduce the participants, SEAQIS' personnel and teachers, how drones can be used for STEM education. It is a learning model that integrates aspects of science, technology, engineering, and mathematics. STEM education is one of the alternative learning models that is considered capable of preparing 21st-century humans.

The training was conducted at the PPPPTK IPA building on the 11th and 12th of February 2020. The event was attended by 40 participants coming from relevant educational institutions and organizations. The event was also brought directly by Paul Mead, the Managing Director and Education Director of SHEMAPS, and Dr Karen Joyce, a geospatial scientist from James Cook University.

The training activities started with the introduction of drones, its functions, and how to control it.

Dr Karen provided several examples of the benefits of drones from her works and how drones helped her. Dr Karen Joyce and Paul Mead demonstrated how drones can help the learning activities in school, especially on STEM education. They also showed that drones are not that complicated to operate for both young and old people, with a multitude of potentials that continue to multiply. They also demonstrated a simple and easy activity to practice in the classroom by mapping the green areas in the surrounding environment using ScribbleMaps.com. Next activity was the introduction of SHEMAPS, an Australian company that supports this programme. Dr Karen emphasized the low representation of women in STEM-related jobs. It then followed by playing baseball using drones.

From this programme, it can be concluded that with the capability to fly aloft and the possibility to go into dangerous areas, drones can be used to complete specific tasks in daily life. For example, drones can be used to locate missing persons on a search-and-rescue mission. It can also penetrate smoke to help to fight a fire. Moreover, drones are capable to deliver objects to a distant location. Many drones nowadays are designed to equip with a camera. Since drones bring a camera into a new birds-eye perspective, aerial photography or videography has been commonly used in commercial video production, news reporting, and scenery photography. It also helps the police to conduct a search of criminal in a wide area from a top-down view. On the other hand, controlling drones can be regarded also as a sports activity and international drone racing competitions have been organized in recent years. Another innovative application of drone is to create a light show using multiple drones. Recently, a drone light show in China has broken the Guinness World Record for the most drones flown simultaneously. As reflected by these examples, drone technology has provided ample opportunities to improve the working practices in our daily life.

Seeing the level of complexity, especially for students, and the high cost to conduct learning using drones, several teachers asked how schools could implement this learning. "Start with small things," said Paul Mead. He acknowledged that not all schools are currently able to implement learning by using drones, mainly due to the substantial costs. He also added that teachers should not underestimate the ability of children to use technology. Children who grow up in the era of technology nowadays can master simple technology like drones. Start small on a scale of one class before starting big, he added.

Workshop participants tried to fly the drone

Partcipants of the In-House Training.
Seen Dr Poppy Kamalia Devi was taking notes.

IN-HOUSE TRAINING ON COMPUTER SCIENCE EDUCATION:

INTEGRATING COMPUTATIONAL THINKING INTO SCIENCE LEARNING

Preparing for the implementation of the SEAMEO Strategic Plan 2021-2030, SEAQIS chose a scientific priority agenda regarding Digital transformation. Therefore, to improve the ability and competence of institutions in the field, SEAQIS held In House Training (IHT) for staff and stakeholders about Computational Science Education. IHT Computer Science Education: Integrating Computational Thinking into Science Learning was internally held to understanding the concept of computational thinking and its integration in learning science.
In this training, SEAQIS collaborated with Bebras Indonesia. Bebras is an international initiative to promote Computational Thinking, among teachers and students starting at the elementary level, as well as for the wider community.

IHT was held from 28 to 30 January 2020 in SEAQIS, delivered by Dr Inggriana Liem from Bebras Indonesia, and also Maresha Caroline Wijanto, S.Kom., M.T. as an informatics expert who is also an Indonesian Bebras team from Maranatha University. This activity was attended by 26 people consisting of 20 SEAQIS employees, 4 invited participants from the PPPPTK IPA Bandung, and 2 invited participants from the Ministry of Education and Culture.

On the first day, the facilitator, Dr Inggriani Liem, introduced computer science and its position in computational thinking. She revealed about computational thinking and also gave examples of computational thinking test questions. She also introduced Bebras, an international non-profit organization that promotes informatics and computing thinking.

Meanwhile, the program on the second day was facilitated by the Bebras team from Maranatha University. They provide strategies for integrating computational thinking into science learning. this session also carried out group assignments to determine science teaching materials at elementary, junior high and high school levels in Biology, Physics, and Chemistry and then analyze the CT contained in the learning process of the material. After the group discussion, each representative of the Biology/ Physics/Chemistry group presented the results to be discussed together.

Dr Indrawati accompanied with Dr Inggriani Liem during the opening ceremony of the programme

On the last day, the program was facilitated by the Bebras team from Parahyangan University, when participants discussed learning assessments using Higher Order Thinking Skills (HOTS). The participants were also asked to make HOTS test items in groups.

After the participants succeed in making the HOTS test items, it wished that the IHT training program can help to understand the concept of computational thinking and its integration in learning, as well as understanding the assessment of computational thinking learning. Moreover, IHT is also expected to improve staff competence in facilitating teachers, especially in computational thinking.

Introducing computer science and its position in computational thinking by Dr. Inggriani Liem

All SEAQIS personnel with Dr. Inggriani Liem

SEAMEO - University of Tsukuba Symposium VIII:

Education for Inclusive Growth on 4th Industrial Revolution for Society 5.0

Dr Indrawati and Dr. Elly Herliani presented STEM learning and industry articles

Dr Indrawati and Dr Elly Herliani received the visit of the symposium participants

On February 13-14 2020, SEAMEO - University of Tsukuba Symposium VIII was held on University of Tsukuba, Japan. The theme of this symposium is 'Education for Inclusive Growth on 4th Industrial Revolution for Society 5.0'. The event's participants consisted of former Secretary-General of the Ministry of Education of Thailand, and other from various places such as SEAMEO Centres, King Mongkut's University of Technology, Moscow Centre for Continuous Mathematics Education, Korea National University of Education (KNUE), and National Institute of Education (NIE) Singapore. The goals of this symposium are to provide platform driven by Industrial Revolution 4.0, to clarify problems in education, to share educational reform, challenges and problems in terms of global citizenship, and to discuss education for sustainable development, inclusive education, human characters developed by the school, soft-skill, and lifelong learning which are needed by Society 5.0.

The symposium was conducted in two days with several sessions in each day with a total of 22 speakers. In the first day, Dr Kiyoshi Karaki as the chair of the Global Teacher Education Committee delivered an opening remark. Dr Kritsachai Somsaman, Deputy Director for Administration and Communication of SEAMEO Secretariat delivered his opening address and opened the session. A total of 15 speakers on the first day shared their knowledge on topic ranging from Challenges and Diversity in Industry 4.0 and Education for Sustainable Development: The SEAMEO Agenda in Industry 4.0 era.

The second day started with the Lesson Study delivered by Prof. Dr Masami Isoda in Elementary School Laboratory of Tsukuba University. The symposium then continued with the remaining 7 speakers who delivered their ideas on various topic such as Human Character Formation through Curriculum Integration and Inclusive Education for Society 5.0.

The last session consisted of synthesis and closing message. Dr Wahyudi, the Deputy Director for Programme and Development of SEAMEO Secretariat, synthesized all of the discussions from the previous two days. Prof. Dr Masami Isoda expressed his joy since every keynote speaker and presenter had contributed in developing Centre programmes to keep up with current development, and to achieve goals of each centre in supporting education development in the region, and become the leader in every field of each centre's focus.

The Earth is Heating Up: Do You Care?

Nanang Setiadi, S.Pd

The idea of the greenhouse effect is sometimes confusing for many people. What is the greenhouse effect? Does it already exist from the past? Do modern human activities cause it? What is the relationship between the greenhouse effect and the increase in earth's temperature? Then, what is the impact of the increase in earth's temperature with human life?

Online Resources:
www.bbc.co.uk/bitesize/clips/zfmb4wx
www.environment.gov.au/climate-change/climate-science-data/climate-science/greenhouse-effect
www.nationalgeographic.com/environment/global-warming/sea-level-rise/
www.pmel.noaa.gov/co2/story

To understand the greenhouse effect, the following quotes would help:

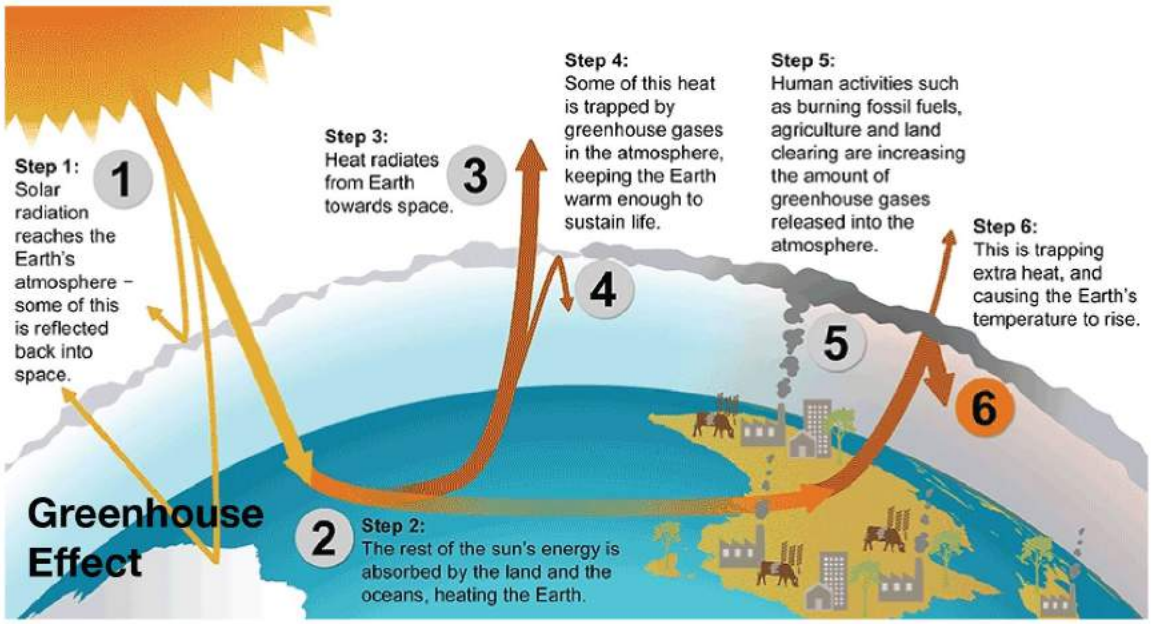
The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected space and the rest is absorbed and re-radiated by greenhouse gases.

Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, ozone, and some artificial chemicals such as chlorofluorocarbons (CFCs).

The absorbed energy warms the atmosphere and the surface of the Earth. This process maintains the Earth's temperature at around 33 degrees Celsius warmer than it would otherwise be, allowing life on Earth to exist ("Greenhouse Effect").

Based on the quote above, we realize that the greenhouse effect is something natural in the earth's atmosphere. It is the earth's natural system that mainly functions to maintain the earth's surface suitable for life. Therefore, we understand that the greenhouse effect is something beneficial for life on earth. Without it, there could not be any life because the earth's temperature might be either too cold or hot. Then, what are the relationship between the greenhouse effect, modern human activities and the increase in earth's temperature?

The following image about the greenhouse effect may be able to simplify our understanding of the relationship.



Source: Australia, Dept. of the Environment and Energy, "Greenhouse Effect".

The first step of the image indicates that the sunlight coming to the earth is partly reflected in the space by the atmosphere and white earth's surface. The white surface on earth is the earth surface covered by snow. Interestingly, it functions to reflect the sunlight to space and decrease the earth's temperature.

The second step describes that the rest of the sunlight is absorbed by the darker earth's surface like the ocean and land. The light surface reflects more heat than the darker surface, known as the albedo effect ("The Albedo Effect"). The sunlight energy absorbed by the ocean and land heats the earth's surface temperature. Some heat absorbed by the earth's surface is radiated towards space, but some are trapped in the atmosphere. It functions to keep the earth's temperature warm at average 33 degree Celsius (the third and fourth steps). This average temperature makes the earth is suitable for life.

The fifth step gives us a description of the human activities that can distract the natural greenhouse effect. Many modern human activities emit a lot of greenhouse gases that contribute to the increase in greenhouse gases concentration in the atmosphere. The increase impacts the change of the greenhouse effect on the earth. The more greenhouse gases in the atmosphere, the more heat trapped in the atmosphere. The result of the excessive trap is the earth's temperature increase (the sixth step).

The description of the relationship between modern human activities and greenhouse effect gives us a suggestion about the importance of decreasing human activities' emission. Some human activities emit greenhouse gases such as the use of fossil fuel. In the modern era, there has been a massive need for fossil fuel use for vehicles and industrial machinery. Unfortunately, the use of fossil fuel emits greenhouse gases like Carbon Dioxide (CO2) that contributes to the increase of the earth's temperature.

The earth's temperature increase can affect the human's life. As the consequence of the temperature increase, there will be more ice melting on earth, both the continental and sea ice. The melting of the continental ice, the ice coming from the snow falls, contributes to the rise of sea level since it adds the ocean water volume. Christina Nunez states that "The increase of sea level can cause destructive erosion, wetland flooding, aquifer and agricultural soil contamination with salt, and losing habitat for fish, birds, and plants".

On the other hand, the sea ice melting, the ice coming from the freezing ocean, does not contribute to the sea level rise since the ice is a part of the ocean. When the sea ice melts, it does not add to the ocean's water volume. However, sea ice melting affects the earth's surface colour change. As previously discussed, the Albedo Effect states that "the light colour reflects more heat than darker colour". The white colour of snow on earth has an important role to reflect the sunlight to space. When the sea ice melts, the colour of the ocean will be darker. The dark colour can cause an increase in heat absorption by the ocean. As a result, the ocean's water temperature increases. The increase in the ocean's water temperature can cause thermal expansion. When the ocean's water temperature increases, it expands. The expansion causes the sea level to rise. It has been a fact that the average sea-level rise at the average is 3 mm per year.

The increase in CO2 concentration in the atmosphere can cause the rise of CO2 concentration in the ocean. It affects ocean acidification. Ocean acidification is the reduction of seawater PH due to the excessive CO2 concentration ("Ocean Acidification"). The ocean acidification has an impact on ocean biodiversity. Algae and seagrasses may benefit from higher CO2 increase in the ocean since they need CO2 for photosynthesis. However, some calcifying animals like oysters, clams, sea urchins, shallow water corals, deep-sea corals dan calcareous plankton suffer from the ocean acidification. It can decrease their population. The decrease of their population can disturb the ocean's ecosystem including fish population. Today, a lot of human beings rely on fish as one of the food resources. The decrease in fish production in the ocean can cause less protein supply for human.

Therefore, realizing the potential danger of excessive greenhouse effect, people should start considering the solution to provide human needs without endangering nature. People should be able to find some alternative energy for fulfilling their needs. Today, we depend on the fossil fuel energy for our daily life which endangers the nature and human's future life. The easiest and simplest thing that we can do is to change our habit of always relying on fossil fuel in our daily activities. If you can ride a bicycle or walk, why should you ride a car?

Contagion

Directed by	: Steven Soderbergh
Produced by	: Michael Shamberg, Stacey Sher, Gregory Jacobs
Written by	: Scott Z.Burns
Starring	: Marion Cotillard, Matt Damon, Laurence Fishburne, Jude Law, Gwyneth Paltrow, Kate Winslet and Jennifer Ehle
Genre	: Medical, action, thriller
Running time	: 106 minutes
Distributed by	: Warner Bros Pictures
Release date	: September 3, 2011

Source: https://www.rottentomatoes.com/m/contagion_2011

Beth Emhoff (Gwyneth Paltrow) died as soon as she returned from her business trip to Hongkong. A couple of hours after the medical team declared her death, her son died. Before dying, Beth Emhoff showed signs of flu and seizure. There were more people die and showed the same symptoms in the next couple of days.

Dr Leonora Orantes (Marion Cotillard), an epidemiologist, together with the World Health Organization (WHO) received information that the outbreak spread from an apartment complex in Hong Kong. WHO sent her to Hong Kong where she found that Beth Emhoff was the index case.

Dr Ellis Cheever (Laurence Fishburne) dispatched Dr Erin Mears (Kate Winslet), an Epidemic Intelligence Service officer, to Minneapolis to investigate. She traced the outbreak back to Beth. Meanwhile, at the Center for Disease Control and Prevention (CDC), Dr Cheever worked with Dr Ally Hextall (Jennifer Ehle) to find the vaccine.

Inspired by Flu Pandemic and SARS

This is a medical thriller film inspired by pandemics such as the 2003 SARS Epidemic and the 2009 flu pandemic. In the writing of the script, Soderbergh and Scott Z. Burns consulted with the representative of the WHO as well as medical experts. The 2009 flu pandemic helped them to provide a glimpse of the chaos in society. It showed some examples of bafflement, helplessness with lack of information allow theory conspiracy to spread disinformation and fear, which is more dangerous contagions than the virus itself. The film also explores how some characters break existing rules for selfish or selfless reasons.

The film was budgeted at $60 million and made $135 million in box office revenue during its theatrical run. It received 85% positive review from Rotten Tomatoes and 70 scores from Metacritic. The film also received renewed popularity in 2020 due to COVID-19 outbreak.

AN IMPLEMENTATION OF STEM PROJECT-BASED LEARNING (PJBL) MODEL ON CRAFTING AN EARTHQUAKE-SAFETY ELECTRICAL INSTALLATION TO IMPROVE STUDENTS' LEARNING MOTIVATION

Abstract

The earthquakes that often occur in Mamuju Regency gave me an idea to teach students to make something useful for protecting the community from earthquakes. Based on the students' learning backgrounds in electrical installation engineering, plus applying the STEM PjBL learning model, the project of crafting earthquake-safety electrical installations was born. As for this research, it is qualitative in nature, with 32 twelfth graders studying TITL in SMKN 1 Mamuju in the 2019/2020 academic year as research subjects. The research took place from March - November 2019 in the workshop of the TITL vocational program of SMKN 1 Mamuju. All the STEM PjBL learning syntax/stages of reflection, research, discovery, application, and communication are used. The earthquake-safety electrical installation circuit is expected to work as the following: if a strong earthquake occurs, the home installations will automatically turn off and the circuit will sound an alarm/earthquake siren. When the situation is safe, the home installations will turn on again and the siren will turn off. The results showed that students were able to build a valid earthquake-safety electrical installation circuit after making 2 product revisions by replacing and adding several electrical control components to refine the performance of the circuit. By doing this project, it has been shown that the students of TITL SMKN 1 Mamuju 2019/2020 academic year's learning motivation in class have improved.

Introduction

Considering Mamuju Regency's earthquake frequency, I found the idea for teaching the students to design a specific electrical installation. In theory, this installation will function as an alarm as well as a safety switch, turning off all electrical installations at homes or offices automatically in the case of a violent earthquake.

To realize the idea, I designed a lesson using a STEM-based approach with the purpose to craft the installation in the form of electrical circuits. This is done to equip the students with skills on making their homes ready for earthquakes as well as to reduce the number of earthquake victims in the Mamuju Regency and also the Western Sulawesi Province in general.

Research Methodology

a. Research Design

This research is qualitative in nature. The crafting of the electrical circuit product is done by way of direct practices by twelfth graders studying TITL (Teknik Instalasi Tenaga Listrik/electrical installations engineering) in SMKN 1 Mamuju during the 2019/2020 academic year. The practices are done under the teachers' supervision.

b. Place and Time of the Research

This research took place at the workshops of SMKN 1 Mamuju, starting from March until November 2019.

c. Research Subjects

The research subjects are 32 twelfth graders in the TITL (Teknik Instalasi Tenaga Listrik/electrical installations engineering) vocational program of SMKN 1 Mamuju.

d. Research Instruments

a. Demo observation sheets
b. Questionnaire sheets

e. Data Collection Methods

The data are collected by way of:

a. Observations
b. Questionnaires.

f. Data Analysis Techniques

1)Qualitative data analysis

Validity analysis of the instrument results was done by two experts using Gregory's content validity formula (Ruslan, 2009, p. 19):

$$\textit{Content validity} = \frac{D}{(A + B + C + D)}$$

The conclusions of the two experts' agreement were taken, and are then processed in accordance to the diagram below:

Tabel 1 Diagram of Gregory's content validity analysis

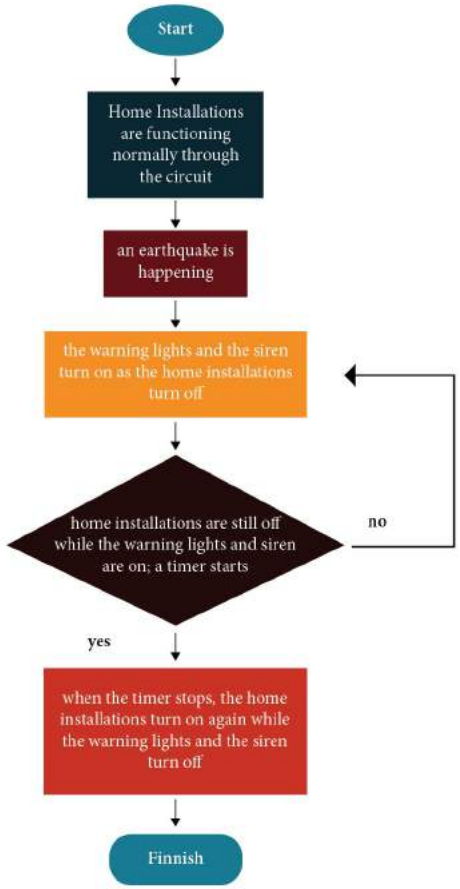
		Expert Judge 1	
		Weak relevance (item rated 1 or 2)	Strong relevance (item rated 3 or 4)
Expert Judge 2	Weak relevance (item rated 1 or 2)	A	B
	Strong relevance (item rated 3 or 4)	C	D

2) Quantitative data analysis

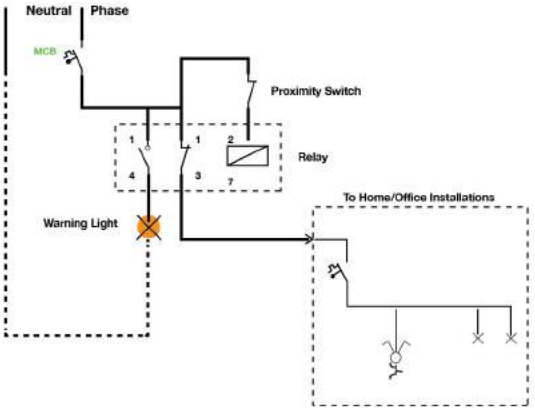
An analysis was done linking the practices of students making their homes earthquake-ready with STEM learning's effects towards students' learning motivation. Such an analysis was done to find a significant cause-effect correlation (Tiro, 2013, p. 12). The data was analysed using the product moment correlation analysis on the SPSS program.

Findings and Discussion

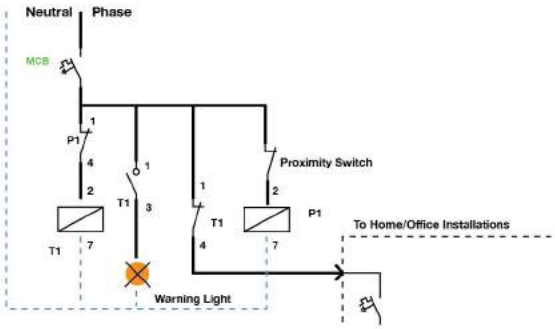
The syntax/stages of STEM PjBL learning which includes reflection, research, discovery, application, and communication are conducted. The expected working principles of the electrical circuit are: when a violent earthquake occurs, it will automatically cut off all electrical currents flowing toward houses and a siren will go off as a warning to people inside that an earthquake is happening; if the situation has calmed down, the circuit will stop cutting off the electrical currents flowing toward houses (so it flows normally again), with the siren turning off. The following is the flowchart that will demonstrate the working principles of the circuit as expected:



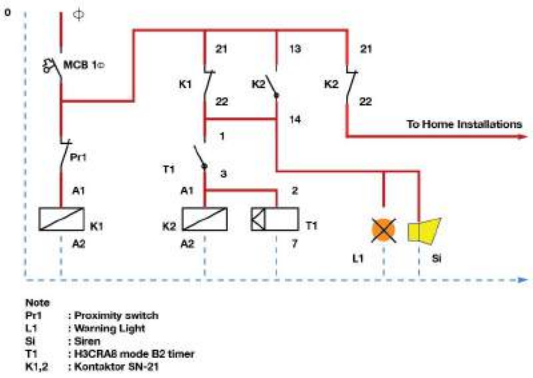
Next is the first design of the circuit by the students:



There was a flaw in this design, that of the electrical currents turning off every time they come into contact with the metallic sensor. This makes the electrical currents turning on and off until the metal—which functions as a motion detector—stops working. Because of this, a revision was made, with the addition of a timer to delay the on/off mechanism as the following picture shows.



When the design above was implemented, it turned out that there was still a flaw. The timer cannot properly delay the home installations turning on, so that when the metal moves away from the proximity sensor, the timer will turn off. A revision was made again by changing the relay with a contactor to maximize the circuit's performance. The following picture represents this new design:



After the students have tested the circuit as made according to the third design, no further revisions are needed because the working principles have already met our expectations.

Afterwards, there was a thorough evaluation and reflection stage for the whole activities (Putra, 2013, p. 174). In this research, students' learning motivation after the project are measured.

The collection of this data was done by way of questionnaire sheets given to the students to find out their responses toward STEM learning. In addition, there was also demo observation sheets filled in by teachers to measure the students' learning motivation. The data were then analysed using SPSS to find a correlation between the effects of the STEM-based project with the students' learning motivation. The followings are the output:

Results of the Product moment correlation analysis on SPSS 23

Correlations

		STEM	MOTIVA-TIONS
STEM	Pearson Correlation	1	.779**
	Sig. (2-tailed)		.000
	N	31	31
MOTIVASI	Pearson Correlation	.779**	1
	Sig. (2-tailed)	.000	
	N	31	31

**. Correlation is significant at the 0.01 level (2-tailed).

From the table above, it can be seen that the sig. value (2-tailed) at the 0.01 level (0.0000 < 0.01) is significant. Therefore, a significant correlation is found between the STEM PjBL learning model's implementation by the project of making a house earthquake-ready and the learning motivations of the twelfth graders studying TITL at the SMKN 1 Mamuju.

Conclusion

The results have shown that the STEM PjBL model is able to encourage students to think critically during the crafting of a product. If students are only taught about theories and expected to practice them, they will not develop the habit of solving problems independently; this is due to their being dependant upon their teachers for learning. On the other hand, doing projects such as the one done in this study will help the students in the achievement of 21st century skills that they must have, which are the 4Cs (communicative, collaborative, critical thinking, and creativity).

Real-life problems such as the frequency of earthquakes in Mamuju Regency, if given to the students to solve according to their learning backgrounds—although of course under the teachers' supervision and collaboration, along with a student-centered learning approach—can stimulate their creativity. Students participating in such projects can refine the flaws they found during the learning process on their own, as this research have shown. Quan, as cited in Khairah (Khairah, 2018, p. 235) also stated that STEM is very well-suited to help students develop new products.

Hani & Suwarma (Hani & Suwarna, 2018) also stated that the goals of STEM learning is not only to improve the students' comprehension on science, technology, engineering, and mathematics, but also for them to implement what they know in solving complex problems. This complex problem solving is ultimately

done for the purpose of developing high-order thinking skills, which is in itself done to prepare the needs of the 21st century.

The results of this research proved the theory which said that students' learning motivation can be improved by way of encouraging them to channel their curiosity by exploring questions and problems, discussing them so that teachers can create a conceptual conflict as a stimulation for the students (Slameto, 2013, p. 177). A similar research conducted by Hani and Suwarna have found that students who participated in STEM-based learnings have higher learning motivations compared to those participating in conventional learning methods (Hani & Suwarna, 2018, p. 67)

Teachers are expected to uncover their students' potentials through the formulations of problem-based ideas so that learnings are not teacher-centered anymore, but student-centered. Other factors that increase students' learning motivation are the use of varying learning models, learning media, and classroom management (Djamarah & Zain, 2013).

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THE EFFECT OF STEM PJBL LEARNING MODEL OF ANDROID BASED WASTE MANAGEMENT ON STUDENTS' CRITICAL THINKING SKILLS

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Laboy Rush's PjBL STEM (Science Technology Engineering, Mathematics) learning is a learning model in five stages, they are reflection, research, discovery, application and communication. This research is the application of colloidal material on the waste treatment of boarding school assisted by Android Mobile Phone Education Media to improve students' critical thinking skills. This research was conducted in class XI-10 of Taruna Nusantara High School in the Academic Year 2019/2020, as a sample taken with random cluster sampling. The hypothesis of critical thinking ability is tested through t test. The results showed that the PjBL STEM learning model affected on student's crtical thinking skill in colloidal material, as indicated by the mean of pretest score is 23.667 and posttest score is 83.967 in the 0.00 significance.

Keyword: PjBL, STEM, critical thinking skills, colloidal material, Android Mobile Phone Education Media

Introduction

Based on data from the Central Statistics Agency in 2016, Indonesia is still dominated by 88 million unskilled workers, 22.1 million skilled workers and 6.5 million experts. The National Science Foundation states that within the next 10 years, employment requires the ability of science, technology, engineering, mathematics (STEM) competencies (Nurdiansyah, 2016). Based on that fact, education must be STEM oriented to answer the needs of global challenges. STEM education does not separate but integrate aspects of science, technology, engineering, mathematics in a single unit that is connected as a whole to produce technological products that can answer the problems that exist in society. Science learning should produce a generation that masters science so that students can train to understand the environment and participate in making appropriate decisions.. Technology mastery is used to develop a device/design to answer the needs of many people and mathematics is used to predict possibilities that can be applied to other situations and communicate ideas effectively to find a variety of smart solutions for the surrounding environment. The application of STEM integrates learning to design technology that can solve environmental problems.

SMA Taruna Nusantara is a boarding school where students' meals are provided by the school kitchen. School kitchens produce waste every day, one of which is banana peel, which is the most served fruit. This is an environmental problem that must be solved. This problem can be related to 11th grade chemistry learning material about colloids in the 4.14 basic competency which is making food or other products in the form of colloids. Based on that problems, researchers tried to combine the STEM PjBL learning with the content of processing of school kitchen waste in the form of banana peels to be processed into valuable food with the help of android and internet media.

This research follows previous research (Jauharriyah & Suwono, 2017) which concludes that Laboy Rush STEM-PjBL can improve scientific literacy, motivation, material understanding, creative thinking skills, effectiveness, meaningful learning, and support future careers. According to Capraro (2013), STEM PjBL learning trains students to think critically, creatively, analytically and improve higher order thinking skills.

Laboy Rush PjBL-STEM

STEM is a learning approach that connects four fields namely science, technology, engineering, and mathematics into a holistic whole (Bybee, 2013). STEM learning does not separate but integrate the four fields in a comprehensive and integrated manner to produce a technology product that is able to solve problems in the surrounding environment. Laboy Rush STEM PjBL learning consists of 5 stages (Laboy-Rush, 2010), namely:

Stage 1: Reflection

The aim of the first stage is to direct students into the context of a problem and inspire them to start investigating the problem.

Stage 2: Research

Second stage is students make their abstract comprehension of a problem concrete. Teachers supervise discussions to determine whether their students have developed a conceptual and relevant understanding of a project.

Stage 3: Discovery

The third stage, the teacher divides students into small groups to present solutions to problems, collaborate, and build cooperation between friends in groups. Students design or design procedures and find the most effective solution.

Stage 4: Application

At this stage the students test the product and find solutions to solve the problems encountered when retrieving the data and the best results. Students test products made from determined requirements. The results obtained are used to improve the previous steps.

Tahap 5: Communication

The final stage is communicating between groupmates and classmates through presentations to develop communication and collaboration skills as well as the ability to receive and apply constructive feedback.

Critical Thinking Skills

According to (Ennis, 1996) "critical thinking is reasonable, reflektive thinking that is focused on deciding what to believe or do". According to this definition, critical thinking emphasizes thinking reasonably and reflectively which make sense to make a judgement. When thinking critically, people will go through stages which are clarification, evaluation, inference, and strategy/tactic.

Research Method

This study uses One Group Pretest-Posttest Design (Sukmadinata, 2010, p.209; Fraenkelet al., 2011, p.270). Treatment is carried out by providing Laboy Rush project-based learning (PjBL) integrated with science, technology, engineering, and mathematics (STEM). This research is a descriptive study by conveying data, processing data, interpreting data so that conclusions are obtained. This method is used because it is compatible with research needs, namely to obtain information about the application of the STEM PjBL model so that it affects students' critical thinking skills.

Research Subject

The subject of this research is 30 students from 11th grade in the 2019/2020 academic year of SMA Taruna Nusantara.

Research Phases

1. Preparation Phase

Analyzing high school chemistry syllabus for class XI, analyzing STEM PjBL learning models, analyzing critical thinking skills, analyzing colloidal concepts, and selecting research subjectswere done in this step. After conducting the analysis, the researchers then compiled the lesson plans, worksheets, and critical thinking skills pre-test and post-test instruments. Before being tested as a pretest, the test instrument was validated by experts. The instrument was then tested on another class (not the treatment class) and statistically tested for validity and reliability.

2. Implemetation Phase

The implementation phase of this research includes 1 meeting for the pre-test, 2 face-to-face meetings in class, 1 meeting in the laboratory to work on making food, and 1 meeting for the post-test. Before applying the STEM PjBL model, a pre-test was conducted to determine the students' critical thinking skills before being treated. The next stage is applying the Laboy Rush STEM PjBL learning model to the colloid concept with the help of students' worksheet, android mobile phone education media, and the internet to ask students to think critically. After learning is done using the STEM PjBL learning model, a post-test is conducted to find out whether the application of STEM PjBL can affect students' critical thinking abilities.

3. End of Research Phase

Data obtained from observation sheets, students' worksheets, pre-test and pos-ttest are analyzed and interpreted in the results section and findings and discussion section in order to obtain conclusions.

4. Data Processing

Data collection techniques used in this study are tests to measure critical thinking skills. The instruments used are pre-test and post-test instruments to measure critical thinking skills. Before being used, the instrument was validated by the lecturer by content validity. After being declared valid, the instrument was then tested for validity and reliability by being tested on class XII who had received material on colloid. Validity test used statistical analysis of Shapiro Wilk with SPSS 21.00 computer program (Arikunto, 2010: 211), and 20 item are shown to have r count values more than r table (0.361) where the r count value is high with a significance of less than 0.005 which indicate that all test items are valid.

Reliability test using the alpha coefficient method using the SPSS 21.00 computer program (Nasution, 2002: 78), obtained a reliability value of 0.897. It is said to be reliable if the value is more than 0,700. Thus, it can be concluded that the instrument is reliable and can be used for research.

Results and Results Analysis

1. Results

Before testing the hypothesis, a normality test is performed as a prerequisite test to find out whether the research data is normally distributed or not. The normality test used is the Shapiro-Wilk test. The normality test results of the research data can be seen in Table 1.

Table 1. Critical Thinking Ability Pre-test and Post-test Normality Test Results

Data	N	Sig	Notes
Pre-test	30	0,243	Normal Distribution
Pro-test	30	0,148	Normal Distribution

Source: Processed Primary Data, 2019

After the normality test is done, the hypothesis test is carried out to measure the increase in students' critical thinking skills after the STEM PjBL learning. Hypothesis testing method used is paired t-test to test the differences between the pre-test and post-test results which can be seen in table 2.

Table 2.Paired t-test results on the critical thinking skills pre-test and post-test

Dependent Variable	Mean	T	Sig	Conclusion
Pre-test	23,667	-27.320	0,000	There is a diference
Pro-test	83,967			

Source: Processed Primary Data, 2019

In the hypothesis test, it can be said there is a difference if the significance value obtained is <0.05.

Results Analaysis

This study used the Laboy Rush PjBL model (Laboy-Rush, 2010) with five stages, namely:

Stages 1: Reflection

The reflection phase aims to bring students into the context of the problem and inspire students to begin investigating immediately. This phase is intended to connect what is known and what needs to be learned. The teacher distributed worksheets and android mobile phone education media application software to students. The teacher made an apperception to stimulate students to think critically by showing pictures of a solution of sugar, milk and brewed coffee drinks. The teacher then asked the question, "What is meant by mixture?" Give the difference between the three pictures!". The teacher provided opportunities for students to answer questions. A student named Khansa answered that some were clear and some were murky. The student named Yudha answered that the sugar and milk mixture did not precipitate while the coffee suspended. Then, the teacher explains that in order to know the differences in the properties of the three mixture, we will learn about colloids. Through those answers, it appears that students have understood the definition of mixtures, differences in solutions, colloids and suspensions through pictures shown by the teacher. To foster an attitude of cooperation, the teacher divided 30 students into 6 groups and distributed white manila papers to each group. Students opened an android application to understand the basic concepts of colloids (types, properties and ways to make colloids). After students learned the concept of colloids, the teacher displayed pictures of some foods and products made from colloid (milk, coconut milk, jelly, nata and gelatin). The teacher asks, "What mixture is the made of?" Students answer, "Colloid". This shows that students have understood the basic concepts of colloids based on their characteristics after reading the literature from an android application. In this phase, students are expected to be able to think critically and creatively connecting food manufacturing with the colloidal system dispersedly and condensation with problems in the surrounding environment (boarding schools). At this stage, there is an engineering design process (EDP), which is problem identification.

Stage 2: Research

At this stage, students conduct their research. More of learning process are done in this process such as, student learning progress in concretizing an abstract understanding of the problem. Teachers and students discussed about the problem of banana peel waste from the school kitchen that has not been utilized. At this stage, students begin to think creatively solving problem solutions to become an opportunity. At this stage, students do background research, part of the EDP process, where students look for various sources to get the most effective solution in making nata and jam with colloidal principles.

Stage 3: Discovery

The discovery stage involves a process that bridges research and information that is known in the preparation of the project. Students discussed in small groups to present solutions to problems, collaborate, and build cooperation between friends in groups. Each group designed the work procedures for making nata and jam, defined important factors such as the composition of substances and the most effective and efficient way in making nata and jam. Next, students presented the results of the discussion classically to receive responses and input from other groups. Next students compiled project planning by making a schedule of activities, work procedure design, and planning for reporting. At this stage, students went through a plan solution process, one of the stages in EDP, where students made plans to solve problems.

Stage 4: Application

In the application stage, students worked on making nata and jam then tested the product/solution in solving problems, and compared them with other groups' product/solution. At this stage, students began to make and, ultimately, test the most effective and efficient products that can be used in the process of making nata and jam.

Nata de banana was made by 3 groups with 3 variations of dilution with the ratio of banana peel and water at 1: 1, 1: 2 and 1: 3, with a baking sheet size of 17x22 cm. Three variations of dilution get the results as shown in table 3.

Table 3. Nata De Banana with three dilution variations results

Banana Peel : Water Ratio	Thickness of nata de banana
1 : 1	1,3 cm
1 : 2	0,9 cm
1 : 3	0,6 cm

The thickest nata de banana yields at 1: 1 dilution. Therefore, it can be concluded that the more water is used or the more dilute the banana peel solution is, the thinner nata is produced because the glucose content is fewer. However, the filtering process was much faster if the more dilute when the banana peel solution was dilute.

Jam was made by 3 groups with 3 variations of treatment and the results can be seen in table 4.

Group	Treatment	Results
A	Banana peels were not scraped and boiled twice	Thick,shiny, the color of the jam some what dark
B	Banana peels were scraped and boiled once	Kurang kental, tidak mengkilap, warna selai terang
C	Banana peels were scraped and boiled twice	Kental, mengkilap warna selai terang

From those three variations results, the maximum results came from the third group's treatment. In this stage, students went through make model stage, one of the EDP process stages, where students got the most effective and effective solution based on field data.

Stage 5: Communication

The final stage of the project was communicating between groupmates and classmates. Presentation is an important step in learning process to develop communication and collaboration skill as well as the ability to receive and apply constructive feedback. At this stage, each group presented the results of their project. At this stage, students went through design, reflect, and communication stage, one of EDP process stages, where students redesigned their product based on the results of discussion and reflection and communicated with each other.

After being treated with STEM PjBL learning model, students' critical thinking skills were then measured in post-test by using instrument of critical thinking skills test questions.

Conclusion

There is an increase in students' critical thinking skills after STEM PjBL learning model is implemented by utilizing kitchen waste of boarding schools on Chemistry android-based learning on colloids.

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STEM LEARNING IMPLEMENTATION USING A SIMPLE ARDUINO APPLICATION TO INCREASE STUDENTS' ACTIVITY AND LEARNING RESULT

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STEM Based Learning using Arduino simple project was implemented in three times of lesson. 5E Model was used to design the sequences. The science concepts in this lesson are electric circuit, sound wave and digital technology. The technology was used in this lesson is Arduino which consist of LED project, ultrasonic sensor and blind stick. The student's worksheet is designed in different locus of control, start from guided until open ended. In the final project, the students has to design, build and redesign independently. The exploration and building the project independently give positive effect especially to increase creativity and learning independent. This creativity could be seen in their new product from their result project. Through STEM based learning, there is increasing students learning activities and practices from the first lesson until the third lesson. In addition, there was increasing in knowledge competencies after implement STEM based learning with arduino simple project. The normalized gain score was 0,66 in average criteria for the effectivity of the lesson

Keywords: STEM Basd Learning, 5E Model, Arduino simple project, activity, learning outcome.

Introduction

The advancement of information and technology demands everyone to be able to adapt in changes in lifestyle, work and teaching-learning. For example in science learning, technological advances have allowed various scientific phenomenon presented in the classroom to be observed by students. For example, in Doppler Effect concept, before there was a smartphone, the delivery of the Doppler Effect was only done through simulations but at this time students could immediately observe how the phenomenon occurred and measured.

With technology, students' competence is expectedly not only understanding, but also application, synthesis and even evaluation. For example, technology digital concept in physics, since various digital technology and microcontroller are not luxury things anymore, therefore students' skill and competency should be leads to applicable skills that are useful for their life.

Each student must have skills that are suitable for this development in order to be able to compete for success in life. Some of the skills referred to as 21st Century skills include critical thinking skills, problem solving, communication and collaboration. Learning in the classroom is no longer just a transfer of knowledge but how to use that knowledge to solve factual problems for students. Thus classical learning with various models that are only oriented towards cognitive learning outcomes is no longer an effective way of teaching and learning especially in training these skills to students.

However, the observation result in the field show that learning which is only oriented towards cognitive learning outcomes is mostly done by teachers, especially in science learning. As a result, students' motivation to study science is still low. Likewise the activities of students in the classroom, still in the inadequate category. Students feel not interested in pursuing science because the content presented is more in the form of narrative is not a factual phenomenon. Lack of motivation and learning activities is also one of the possible outcomes of students' learning in science and mathematics still in the inadequate category.

Based on the mentioned problems, in this research an STEM learning implementation will be carried out to improve students' learning activities and outcomes both knowledge and skills. STEM learning is used as an option in this study because of its characteristics as integrated learning between science, technology and mathematics so that it is more applicable and contextual for students. Factual problems that are close to the lives of students generally require an integrated understanding of science, technology and mathematics, inseparable from one another. By applying the concepts they have clearly, it is hoped that learning activities will increase and learning becomes more meaningful so that learning outcomes also increase. In addition, various studies show that Science, Technology, Engineering and Math (STEM) education is very important to achieve the future career success of students by practicing 21st century skills.

STEM learning in this study was carried out using a simple Arduino application. Simple arduino application is an application using arduino with simple projects that can be done by students in the classroom. Arduino itself is a microcontroller that is very popular among the people, especially as a micro-scale regulator in the digital or robotics field. By knowing the basics of arduino logic and some simple arduino applications, it is expected to provide motivation for students to study science and technology more deeply.

The learning in this study is integrated learning between physics, computers and mathematics. In physics, students will first learn about sound waves and how to measure distances by using wave reflection theory. Students also learn about the electronic components and the nature of closed circuits. In the field of technology students will get to know the basics of using Arduino UNO ranging from LED blinks to the use of ultrasonic sensors. In the last session, students must make an application project for the use of arduino ultrasonic sensors in everyday life, for example, making blind sticks or making parking control designs along the road trajectory at school. By directly implementing the engineering process in the classroom to solve the factual problems they find around the school, it is hoped that the learning outcomes of students will increase in both knowledge and skills.

Student learning outcomes are generally divided into three domains, namely cognitive, affective and psychomotor. Bloom et al in 1949 divided student learning outcomes into the cognitive domain known as Bloom's taxonomy. A few decades later, Karthwol, a team from Bloom's taxonomy, along with seven other education experts, proposed a revision of Bloom's Taxonomy for the cognitive domain as shown in Figure 1.

All aspects of the old taxonomy have all changed from nouns to verbs in the new taxonomy. The order of the levels also changes. The aspect of knowledge in the old taxonomy is changed to remember for the dimensions of cognitive processes in the new taxonomy. The synthesis aspect of the old taxonomy has changed to create a new taxonomy and is the aspect with the highest level of coginitive processes.

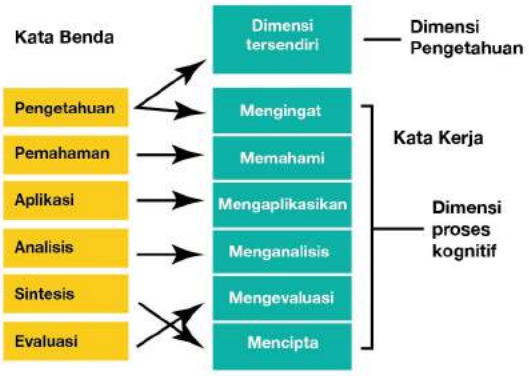

Figure 1. Bloom's Taxonomy Revised by Iyon Suyana (2017) ([1]

Knowledge is a separate dimension with the division of categories, namely factual, conceptual, procedural and metacognitive as in table 1.

Dimension	Definition
Factual Knowledge	The basic elements student must know to be acquainted with a discipline or solve problem in it
Conceptual Knowledge	The interrelationships among the basic elements within a larger structure that enable them to function together
Procedural Knowledge	How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods
Metacognitive Knowledge	Knowledge of cognition in general as well as awareness and knowledge of one's own cognition

Table 1. Dimensions of Bloom's Taxonomy Revision Knowledge
Revise Bloom Taonomy (2017) [2]

To achieve learning outcomes to the stage of creating required integrated learning that prepares and conditions students to be able to achieve it. Classical learning is not currently the right choice because learning prepares more students to cognitive level 2, not to create, to making a product.

One learning that can be used as an alternative in order to achieve learning outcomes to the stage of making products is through learning based on Science Technology Engineering and Math (STEM). Bruning, Schraw, Norby and Ronning (2004) in Sanders (2009) [3] identified the following set of congitive themes that resonate with integrated STEM, namely:

- Learning is a constructive process, not recessive,
- Motivation and belief are integral parts of cognition,
- Social interaction is fundamental to cognitive development,
- Knowledge, strategy and expertise are contextual.

In accordance with the cognitive themes above Sanders (2009) states that integrated STEM education is a practical example of constructivists in learning. STEM provides the context and framework for organizing understanding of science and mathematics and encouraging students to actively build contextual knowledge of science and mathematics, thereby improving memory and the process of transfer of lessons. Integrated STEM education pedagogy is inherently student-centered and knowledge-centered (Bransford, Brown, & Cocking, 2000). When used in group learning, STEM also provides a very strong environment for social interaction that is very important for the learning process. Besides, STEM puts mathematics and science in the context of technological activities so as to increase the value of education, culture and global competitiveness of students in accordance with 21st century skills. STEM learning is one way to develop technology literacy for students as an important factor in efforts to achieve success in the 21st century. As stated by [4].

Technological literacy (TL) is one of the most important qualifications for a 21st century person to acquire (ETS, 2003), and STEM education is important for the acquisition of this qualification. Technological literacy is, "the ability to responsibly use appropriate technology to: Communicate, solve problems, access, manage, integrate, evaluate, design and create information to improve learning in all subject areas, and acquire lifelong knowledge and skills in the 21st century" (Technology Literacy Assessment Project, 2009, p. 1).

In addition to improving technological literacy, through STEM learning students also carry out engineering design process (EDP) which is also a compulsory curriculum in the 21st century as an approach in developing problem solving skills. James R Morgan (2013) [5] states that:

"The design process is a systematic approach followed when developing a solution for a problem with a welldefined outcome". There are many variations in practice today, but most of them include the same basic steps. Following a well-structured design process is important because it provides the structure needed to formulate the best solution possible, and the act of following a design process builds problem solving skills and logic".

The stages of the design process in engineering according to James R. Morgan et al (in Carparo 2013), namely:
1. Problem Identification,
2. Research,
3. Idea Development,
4. Idea Analyze,
5. Build,
6. Test and Refine,
7. Communicate, and
8. Refclection.

One learning model that is compatible with the engineering design process (EDP) is the 5E model. The 5E learning model consists of engagement, exploration, explanation, elaboration, evaluation.

The relationship between the 5E model and the engineering design process can be seen in table 2.

5 E step	Design Process step
Engagement	Identify problem and constraints
Exploration	Research; Ideate; Analyze ideas
Explanation	Research; Ideate; Analyze ideas
Extension	Build; Communicate
Evaluation	Test and refine; Reflect

Tabel 2. Hubungan 5E Model dengan EDP
James R. Morgan (2013) [5]

Thus in this study STEM-based learning will be done with material analysis shown in table 3.

Sains	Teknologi
1) Kecepatan dan sifat gelombang 2) Gelombang Bunyi (Ultrasonic) 3) Rangkaian elektronika (Rangkaian Seri-Paralel)	1) Menggunakan arduino 2) Menggunakan sensor jarak 3) Membuat purwarupa blind stick
Enjiniring	**Matematika**
1) Merancang, membuat, menguji coba, merevisi purwarupa blind stick 2) Mengkomunikasikan hasil rancangan dan hasil ujicoba purwarupa blind stick	1) Logika matematika 2) Menentukan jarak terjauh yang dapat dideteksi sensor 3) Menentukan posisi ideal dimana sensor diletakan pada blind stick 4) Memanipulasi besaran-besaran fisis objek yang dirancang dalam bentuk simbol dan persamaan.

Table 3. STEM Analysis

Research Method

This research is an experimental research using quasi-experimental one group pretest postest method. Learning is divided into three meetings with each learning series consisting of a plan do see stage. At the plan stage is the learning design stage, the do stage is the learning implementation stage and see is the analysis and evaluation stage of learning outcomes. In the initial stages before implementation, students will get a pretest to see the students' initial ability, as long as the teacher's implementation is assisted by the observer will assess the student's performance using the observa-

tion format and after the student's implementation is given a post-test to see the results of their learning.

The instruments used in this study consisted of written test instruments, observation formats, worksheet assessment instruments, design assessment rubrics and engineering process and product assessment rubrics. The test instrument is used to determine the learning effectiveness of each student.

For knowledge learning outcomes, data analysis was carried out from pretest-posttest. The results of the pretest and posttest scores of each student are used to see an increase in student learning outcomes with a significance test. Meanwhile, to analyze the effectiveness of the learning used normalized score gain calculated according to the equation:

$$< g >= \frac{T_1^1 - T_1}{T_{max} - T_1}$$

(Hake, 2008)

Based on the acquisition <g> determined the effectiveness of learning categories of each student based on the criteria in table 4.

Percentage	Category
0,70 < <g> < 1,00	High
0,30 < <g> < 0,70	Average
0,00 < <g> < 0,30	Low
<g> = 0	Stable
-1,00 < <g> < 0	Decrease

Table 4. Success Rate

To see an increase in learning outcomes in the term of skills will be done through the performance evaluation of each student. The performance assessment process will be assisted by the observer when the learning implementation takes place and through video recording. Skill assessment will be determined by several indicators that must be shown by students during learning. If the student shows the indicators that are determined, then the student will get an assessment point. Furthermore, it is analyzed and determined what percentage of students are able to show the specified indicators. Based on this percentage, the students will be observed whether there is an increase or not. Meanwhile, to see whether there is an increase in activity or not, it is done based on observation during learning. Some of the activities observed include asking questions, answering questions, working on worksheets, conducting experiments and discussing activities.

Result and Analysis Result

Broadly speaking, this research implements integrated project-based STEM learning. In order to achieve optimal results, before students make a Blind Stick project, students must carry out simple projects that are useful in supporting the process of making a blind stick. Thus, in this study the implementation of STEM learning was carried out in three meetings or called learning series. Each learning series is designed according to Arduino concepts and projects with the type of Student Worksheet (LKPD) as in table 5.

Series	Science Concept	Arduino Project Target	LKPD Type
I	- Closed circuit of dynamic electricity	LED Lamp Project	Cook Book
	- LED Power Light	Flip Flop Lamp Project	Semi Cook Book
	- Series of parallel-series resistors	Traffic Lights Project	Open
II	- Speed of Sound	Buzzer Project	Cook Book
	- Wave reflectivity	Proximity Sensor Project	Semi Cook Book
	- Proximity Sensor	Determination of Sensor Detectable Maximum Distance	Open
III	Application of Scientific Method	Design, create, test and redesign a Blind Stick	Open

Table 5. Project Design in Each Learning Series

Each group can complete all targeted projects in the learning design. At the first meeting, some groups tend to ask the teacher before reading the instructions in the LKPD. Four of the seven groups always waited for the teacher to explain the activities that had to be carried out compared to reading from the LKPD and trying it themselves. Because they did not read the LKPD well, two groups of seven groups repeatedly made the LED break due to attaching the LED (2.5 V) to the 9 V. battery. Even though the LKPD did not mention steps to connect the LED to the battery. Although all tools and materials are given to each group, not all tools and materials must be used in the investigation process. Learners must choose and sort out what tools are needed and used in the investigation.

During implementation many positive result were found that even exceeded the targets set by the teacher as follows:

- All students are actively involved in learning.

- Practicing computational thinking skills, including pattern recognition. Learners can recognize learned patterns so that they can complete the entire project well.

- Although the first meeting presented was a simple project, the engineering of the process remained visible. After learning how to make LED Blink lights with LKPD in the form of a cookbook (all stages are explained), students are then able to design and make flip flop lights and finally able to design and make traffic lights. During this process, students also find many mistakes both in the language of the program and its electronic circuits. But then they learn how to solve these problems.

- After completion of the entire project, students conduct various explorations without being asked by the teacher. Some groups make disco lights instead of traffic lights for presentation. This is a new discovery because teachers do not teach at all and do not ask students to do that but they find and explore themselves as a manifestation of creativity.

- The learning atmosphere looks very fun for students. Some of the students said that learning physics like this made them excited and motivated them to learn more about physics.

Although many positive results, but based on observers observations found several problems during the implementation of this first series of learning, they are:

- Students are not accustomed to reading LKPD instructions so they are more dependent on the teacher.
- After learning lasts more than one hour, some students started to lose focus in learning.
- In seven groups, three of them are dominated by one or two people in the group while the other group members are more passive during the learning process.
- All students are new to arduino and programming so teacher guidance is needed.
- The teacher rushes to answer all questions from students.

To overcome the problems found during the first learning, based on the results of discussions of observers, teachers and experts from SEAQIS, the next meeting was designed so that teachers give more time to students to explore more independently. The teacher also did not immediately answer questions from students. If there is a group that asks the teacher for help during the investigation process, the teacher asks the group to read the LKPD first. For answers not found in the LKPD, the teacher will answer by pointing out what mistakes were made and teaching patterns to solve the problem. In addition, several revisions in the LKPD are also needed, including:

- To practice new skills, the LKPD made in more detail. So the questions that might arise in the second meeting can be solved if they read the LKPD carefully.
- To practice the process-building skills, some program language writing mistakes were intentionally written by researchers in LKPD. Thus, when students find these mistakes, students learn to solve them, in other words students are trained to develop the learning outcomes of the evaluation phase.

With the design of improvements, in the implementation of learning the two students look more active and more independent during the investigation process. All members in the group are actively involved, share tasks and work together in completing the projects. The new problem that arises in this implementation is the problem of the Arduino UNO tool. Some Arduino UNO does not work properly after being given a program and is not detected by the computer. This problem causes the activity of some students to decrease. But the other two groups, asking for help from the other groups and trying other arduino devices, tried to find what the problem was so the arduino didn't work. From this problem, it can be concluded that the problems that occur can have a positive impact on one group and can also have a negative impact on different groups. Groups that have students in the high competency category will try to solve problems in various ways including trying various possible solutions. But groups consisting only of students with moderate competence will give up and stop learning activities until the teacher helps.

In the third lesson, learning implementation still has problems, the product design activities. After listening to the product that must be made, some students do not write down the design first but instead directly make the product. Only two of seven groups wrote their designs first in the LKPD before make the product. Even so, they did a discussion first on the form and design of the product to be made even though they did not write it in the LKPD. In this third learning series, all students are active and enthusiastic to completing, testing and modifying their products. All groups can work independently and the engineering process activities can be seen from starting to discuss product design, making, testing and redesign the product. Because each group has its own way to design and make its products, no product is the same between one and another. Some groups use LED lights and buzzers as distance indicators, while the others use buzzers. Some other groups also have the initiative to use the switch, decorate the product and most amazingly there is one group whose product sounds the tune when the product detects the object in front of it. Though this is not taught at all in LKPD. Based on these result, it can be seen that student learning outcomes can reach the create stage.

1. Activity and Learning Outcomes

To find out the learning activities of students, observation was carried out assisted by several observers from peer teachers. One learning series consists of 120 minutes which was divided into 12 observation sessions. Every 10 minutes the studenta will be given a check mark on the observation format every time they show activity in learning in the form of observation, asking questions, discussing, reading LKPD conducting investigations and making products. Every 10 minutes of observation during 2 hours of learning, students' activities can be seen in table 6.

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Group	Students' Initial	Series I	Series II	Series III
I	Ama	10	7	10
	Nad	9	6	10
	Ash	11	11	11
	Mar	11	-	11
II	Ghi	11	12	12
	Nuh	10	12	12
	Ary	11	12	12
	Irf	10	12	12
III	Ind	5	8	12
	Nuh	12	12	12
	Dia	8	11	12
	Dza	-	12	12
	Riz	7	10	12
IV	Kan	6	6	12
	Sad	7	7	12
	Sya	12	12	12
	Nau	12	12	12
V	Mar	10	10	12
	Rfa	12	12	12
	Ven	3	3	12
	Dan	12	12	12
VI	Mei	7	11	12
	Sal	9	10	10
	Yan	7	9	11
	Mfa	12	8	12
	Azh	12	12	12
VII	Aly	8	12	12
	Nab	7	5	12
	Ach	11	11	12
	Ava	11	5	12

Table 6. Students' Activity Every 10 Minutes in 3 Hours (Max Score = 12)

In the learning series, students begin to be enthusiastic in learning after the teacher shows a wall-E robot that uses a proximity sensor to move forward or turn. If we take a look at table 6, it appears that at the first meeting some students were not much actively involved in learning. From the results of discussions with observers, it was found that in group III, learning activities were dominated by someone so that the members of other groups were reluctant to participate. This group also has a problem in their Arduino so that its activity decreases. But in the third lesson, all group members were actively involved from the beginning to the end of the lesson. In fact, this group is the group with the fastest product finishing process.

Meanwhile in group V, one student whose activity was the lowest was more quiet and only liked if he was asked to write. This student is lack confidence to conduct an investigation, even lack confidence to simply hold the tools that are available on the table. But at the third meeting, this one students do not lose focus at all to be actively involved in learning.

Based on table 6, it shown that after students have adequate competence both knowledge and skills in arranging Arduino, they will be very active in learning to complete their products. When in the first and second learning, students are still learning to find patterns, doing abstraction and problem solving, at the third meeting they can complete the project independently with their own creativity. Nearly all students are actively involved in learning in full for 2 hours without losing their focus on the third learning. This result provides high optimism for teachers that when students are introduced to basic skills and then given full freedom in learning, innovation and creativity will be displayed as a form of learning outcomes.

The assessment of skills learning outcomes is only focused on three aspects, namely choosing the tools and materials needed, arranging tools according to pictures (fritzing) and writing programs. Each aspect has the assessment criteria listed in the appendix. Based on observations, the results of learning skills are shown in table 7. Based on the table, it appears that students' skills in using Arduino from the first meeting to the third meeting have increased. At the third meeting, students are able to overcome the problem when an error occurs in the compailing process. Students are also able to write their own programs based on their experience.

Group	Students' Initial	Series I	Series II	Series III
I	Ama	11	6	11
	Nad	10	5	10
	Ash	11	12	12
	Mar	11	12	11
II	Ghi	11	9	12
	Nuh	10	12	12
	Ary	11	12	12
	Irf	11	9	12
III	Ind	7	12	12
	Nuh	12	12	12
	Dia	7	12	12
	Dza	-	12	12
	Riz	4	12	12
IV	Kan	9	6	12
	Sad	11	7	12
	Sya	11	12	12
	Nau	12	12	12
V	Mar	11	12	12
	Rfa	12	12	12
	Ven	5	5	12
	Dan	12	12	12
VI	Mei	8	11	12
	Sal	9	10	12
	Yan	10	9	12
	Mfa	12	8	12
	Azh	12	12	12
VII	Aly	10	12	12
	Nab	6	5	12
	Ach	11	11	12
	Ava	10	5	12

Table 7. Learning Outcomes Skills

The learning outcomes of knowledge based on the pretest-posttest values are shown in table 8.

	Highest Score	Lowest Score	Average Score	Sum n	Standard Deviation S
Pretest	8	2	4,20	30	1,45
Postest	27	16	21,23	30	3,16
Gain	0,86	0,46	0,66	30	0,11
Criteria	Tinggi	Sedang	Sedang		

Table 8. Knowledge Learning Outcomes

From the table we can see an increase in learning outcomes with a normalized score gain of 0.66 in the medium category. The number of students who experienced an increase in the high category was 10 people, the moderate category was 20 people and there were no students who did not experience an increase. This achievement is a positive result that although the content of the material is not taught directly by the teacher, students can understand the content through their own activities during project completion.

Thus STEM learning with a simple Arduino application can improve student learning outcomes and learning activities. The results of this study are strengthened by Mukaromah research (2017). The results of his study concluded that there is an effect of STEM learning on improving student learning outcomes [6]. In this study also mentioned that in the STEM learning experimental class, the activity of students continues to increase from each meeting. In contrast to the control class that decreased activity at the third meeting because it began to feel bored with the scientific approach that is usually done in learning. By using technology to solve problems, students are not only trained to identify and understand the technology needed but STEM can also analyze the limits, risks and impacts of using these technologies.

Conclusion

Based on the results of data analysis and discussion it can be concluded that STEM learning using the simple Arduino application can be arranged in stages starting from engage, explore, explain, elaborate and evaluate with every project from the guided project to the independent project. After students implement the STEM learning process using the simple Arduino application there is an increase in learning activities and skills from the first meeting to the third meeting. Likewise for knowledge learning outcomes there was an increase with a normalized score gain of 0.66 in the medium category.

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COMPUTATIONAL THINKING IMPLEMENTATION

Computational Thinking (CT) is an approach to the learning process. CT has an important role in the development of computer applications and CT is also used to support problem-solving in all disciplines including humanities, mathematics and science. Students who learn where CT is applied in the curriculum can see the relationship inter-disciplines and also can observe them both in the class and outside the classroom.

Some of our alumni have implemented Computational Thinking (CT) projects in their schools. The first one was A'irin Nurwidyastuty. She is a teacher at SMPN 1 Kraksaan in Probolinggo, East Java. She was the alumnus of training on Computational Thinking Implementation in 2019. She then implemented the results of the training in her classroom. A'irin considered that implementing CT is challenging. She introduced not only a learning model but also real experience in class.

teaching and learning process using CT at SMPIT Al-Haraki, Depok

During the implementation, she analysed the motion systems of living things. She used two learning methods including Plugged and Unplugged methods. In the plugged method, she used Scratch, a visual programming language for learning environments. It allows beginners to learn to make programs without having to think through syntactic writing. This programming language was created by MIT Media Lab from the Massachusetts Institute of Technology. By using Scratch, users can create their animations, games, artworks, programmes and so on. In this way, students can focus on logic and programming flow (algorithm) without ever or often getting errors due to incorrect syntactic writing. The scripts are represented in different colours so that it is very easy for students to move to the screen for the selected script by looking at the colours.

The second method was the unplugged method or without using the computer. Airin and her students used magnetic technology in the Maglev train. It is a part of the science learning materials applied in grade IX. She received very positive responses during the implementation. The students were very enthusiastic and many students stated that the learning was fun and eliminated boredom.

A similar experience was also experienced by Devi Ika Damayanti, a teacher at SMPIT Al-Haraki in Depok, West Java. She also used Scratch in her class where she found that the students were also very excited and enthusiastic.

"Airin Nurwidyastuti
is teaching her students
to use the scratch application"

"students of SMPN 1 Kraksaan in Probolinggo applying the CT method"

Welcome to Our New Deputy Director

To broaden staffs' skill sets and to avoid falling into a rut in one position, SEAQIS implemented a job rotation policy in early of 2020. This was the strategy face the challenges in 2020. Besides, SEAQIS also has a new Deputy Director for Programme, Mr Reza Setiawan, after Dr Indarjani completed her second term at the end of 2019. Before serving as Deputy Director for Programme, Mr Reza Setiawan served as the head of Programme and Training division.

Mr Reza said that his election as a deputy director was quite surprising. Previously, he only focused on the aspect of programme and training. Meanwhile for his current position he has to organize several aspects at the same time i.e. programmes, data dan evaluation, as well as research and development. As a new deputy director, Mr Reza Setiawan encourages SEAQIS to become the frontline institution in the development of regional science education. It can be done by developing various types of online training so that it can reach more science teachers and education personnel across the region. Furthermore, considering we are already in the era of the industrial revolution 4.0, SEAQIS needs to be able to adopt various developments in communication and information technology to increase the feasibility of the Centre. He then stated that hopefully by having those various models, SEAQIS will be able to offer more reliable programmes to its partners and stakeholders.

In addition to having new programmes offered, he intends to maintain existing programmes carried out by the former Deputy Director, Dr Indarjani. Moreover, he also hopes that all personnel in the divisions can always improve their competences and keep being updated to the relevant knowledge and issues because he believes that the strength of the Centre lies in the strength of its human resources. Since the new year, SEAQIS also recruited two new staffs, Mr Nursidik and Ms Yulianti. Mr Nursidik is while, Ms Yulianti is placed as a Secretariat Officer. Although they do not have any scientific background, they are expected to be able to become qualified human resources to realize the vision and mission of the SEAMEO QITEP in Science.

Mr Reza Setiawan
Deputy Director for Programme

Visits to SEAQIS

At the beginning of 2020, SEAQIS had been visited by four institutions including Education Office of Depok City, Association of Robot Education Indonesia (AREI), Centre for Education Communication, Information, and Technology (Tikomdik), and National Quemoy University (NQU), Taiwan.

The NQU was represented by Dr Yvonne Yu-Fang Yen (Dean of Office of International and Cross-Strait Affairs), visited SEAQIS in February. The visit was intended to socialize the NQU post-graduate program which will be held again in 2021.

The socialization of the 2020 programmes was also carried out by AREI by visiting the Centre in March 2020. Besides, the visit of AREI was also intended to introduce the management members of the organization who had been elected a couple of weeks prior to the visit. Collaboration with AREI itself had been carried out in the STEM seminars in November 2019.

Two Tikomdik staffs also visited SEAQIS to seek potential collaboration in the future. Tikomdik is part of the Education Office of West Java Province. SEAQIS has promoted its programme several times through Tikomdik's radio channel.

Mr Goen Gunawan and Mr Asep Eka, representatives of Tikomdik West Java Province during their visit to SEAQIS

Depok Education Department Visit

AREI team arrived at SEAQIS to socialize their programs

NQU Visit

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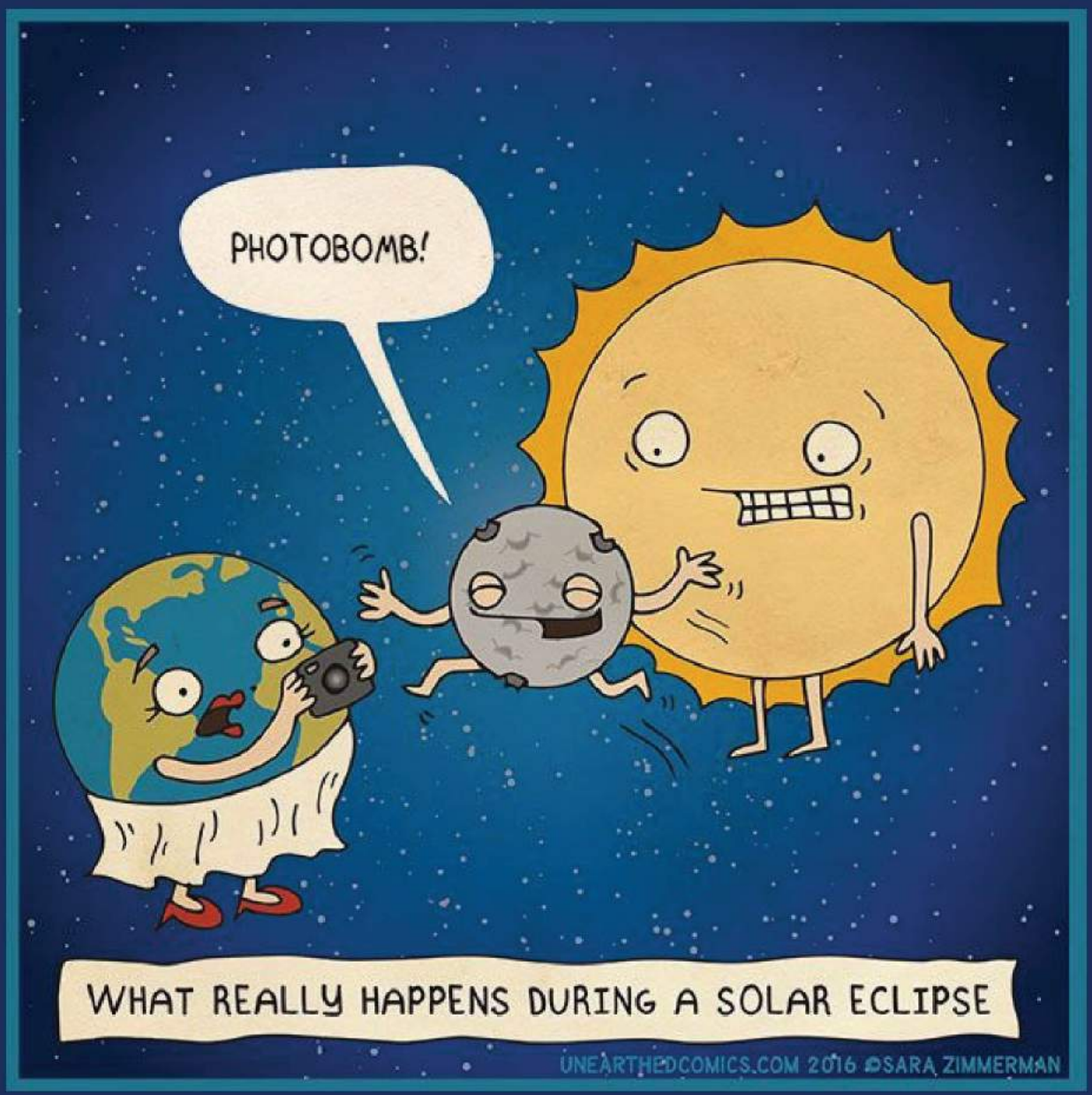

Did you Know?

A solar eclipse occurs when the moon passes in a direct line between the Earth and the sun. The moon's shadow travels over the Earth's surface and blocks out the sun's light as seen from Earth.