LAPORAN AKHIR
PENGABDIAN KEPADA MASYARAKAT INTERNASIONAL
UNIVERSITAS LAMPUNG

INTERNATIONAL WORKSHOP ON STEM EDUCATION: INTEGRATING SCIENCE, TECHNOLOGY, SOCIETY, AND ENVIRONTMENT FOR FOSTERING INSERVICE TEACHER TPACK

TIM PENGUSUL

1. **Prof. Dr. Agus Suyatna, M.Si. NIDN: 0021086003 SINTA ID: 5974519**
2. **Dr Abdurrahman, M.Si. NIDN: 0016806012 SINTA ID: 5978273**
3. **Dr. I Wayan Distrik, M.Si. NIDN: 0015126304 SINTA ID: 6161537**
4. **Hervin Maulina, S.Pd., M.Sc. NIDN: 0023099002 SINTA ID: 6651167**
5. **Novinta Nurulsari, M.Pd. NIDN: 0017119302 SINTA ID: 6671303**

KATEGORI
Pengabdian Kepada Masyarakat Internasional

PROGRAM STUDI PENDIDIKAN FISIKA
FAKULTAS KEGURUAN DAN ILMU PENDIDIKAN
UNIVERSITAS LAMPUNG
2021

HALAMAN PENGESAHAN
PENGABDIAN KEPADA MASYARAKAT INTERNASIONAL
UNIVERSITAS LAMPUNG

Judul Pengabdian : International Workshop on STEM Education: Integrating Science, Technology, Society, and Environment For Fostering Inservice Teacher TPACK

Ketua Pelaksana
a. Nama Lengkap : Prof. Dr. Agus Suyatna, M.Si.
b. NIDN : 0021086003
c. SINTA ID : 5974519
d. Jabatan Fungsional : Guru Besar
e. Program Studi : Pendidikan Fisika
f. Nomor HP : 0852-2004-5573
g. Alamat surel (e-mail) : agus.suyatna@fkip.unila.ac.id

Anggota (1)
a. Nama Lengkap : Dr. Abdurrahman, M.Si.
b. NIDN : 0016806012
c. SINTA ID : 5978273
d. Program Studi : Pendidikan Fisika

Anggota (2)
a. Nama Lengkap : Dr. I Wayan Distrik, M.Si.
b. NIDN : 0015126304
c. SINTA ID : 6161537
d. Program Studi : Pendidikan Fisika

Anggota (3)
a. Nama Lengkap : Hervin Maulina, S.Pd., M.Sc.
b. NIDN : 0023099002
c. SINTA ID : 6651167
d. Program Studi : Pendidikan Fisika

Anggota (4)
a. Nama Lengkap : Novinta Nurulsari, M.Pd.
b. NIDN : 0017119302
c. SINTA ID : 6671303
d. Program Studi : Pendidikan Fisika

Jumlah mahasiswa yang terlibat : Alya Atina dan Ajeng Rahayu
Jumlah alumni yang terlibat : -
Jumlah staf yang terlibat : -
Lokasi kegiatan : Indonesia
Lama kegiatan : 6 (enam) bulan
Biaya Penelitian : Rp. 25.000.000,-
Sumber dana : DIPA-BLU UNILA TA 2021

Bandar Lampung, Oktober 2021

Mengetahui,
a.n Dekan FKIP Universitas Lampung
Wakil Dekan Bidang Akademik dan Kerjasama

Prof. Dr. Sunyono, M.Si.
NIP. 196612301991111001

Ketua Pelaksana

Prof. Dr. Agus Suyatna, M.Si.
NIP. 196008211985031004

Menyetujui,
Sekretaris LPPM Universitas Lampung

Rudy, S.H., LL.M., LL.D.
NIP. 19810104 2003121001

TABLE OF CONTENTS

INTERNATIONAL WORKSHOP ON STEM EDUCATION: INTEGRATING SCIENCE, TECHNOLOGY, SOCIETY, AND ENVIROMENT FOR FOSTERING INSERVICE TEACHER TPACK

SUMMARY

Science, Technology, Education, and Mathematics (STEM) Education has recently become the most trending issue in education. STEM education is considered to be able to overcome real problems that occur in society. Integrating science, technology, society, and environment into learning and instruction processes is inevitable in this modern world, so it is of pivotal importance that all teachers should master Technological Pedagogical Content Knowledge (TPACK) confidently. Unfortunately, the approaches toward teacher education programs in many countries, specifically in Indonesia, do not yet integrate TPACK into the curriculum. Contemporary education presents many challenges for improving the quality of teaching, including the knowledge of instructional practices of teachers in science, technology, engineering, and mathematics (STEM) disciplines. In order to improve the quality of teaching competencies for inservice teachers, the pedagogical content knowledge technology framework (TPACK) can be recognized and basically adopted. Therefore, an international workshop on STEM education: integrating science, technology, society, and environment for fostering inservice teacher TPACK activities was conducted. Informative–participatory method is used in this community service program. The results of this workshop were the improvement of inservice physics teacher TPACK (as a participant) in integrating science, technology, society, and environment of STEM Education can be conducted by doing such kind of workshop which clearly explain and provide experience for all the participants. Beside that, it can be known about the supporting and inhibiting factor for the implementation of the Physics teacher workshop in integrating science, technology, society, and environment in STEM Education respectly are knowledge & technology and the inhibiting factors are inservice teacher don’t have enough time to conduct it escpecially during pandemic covid-19. The output of this workshop is a scientific paper that has been registered at the Seminar Pengabdian Kepada Masyarakat FKIP University of Lampung and will be published in Jurnal Pengabdian Kepada Masyarakat PMIPA FKIP Unila.Through this activity, high school physics teachers are provided with knowledge and skills regarding the integration of science, technology, society, and environment through STEM Education-based learning units and designs that are oriented to the 21st century curriculum.

Keywords: TPACK, STEM Education, Technology, Society

I. INTRODUCTION

1.1 Background Situation

The 21st century learning has consequences for all educational practitioners and learners to continue, develop, and improve the competencies and abilities needed. Integration of several components such as curriculum, literacy, strengthening character education (PPK), higher order thinking skills (HOTS), and other skills that are combined in 21st century learning to provide orientation to practitioners in optimizing all aspects of learning, in order to answer challenges, both internal challenges and external challenges, namely globalization. 21st century learning is simply defined as learning that provides 21st century learning to students, namely the 4Cs which include: communication, collaboration, critical thinking and problem solving, and being creative and innovative. Teachers act as learning spearheads who must be able to plan and implement quality teaching and learning processes. This has consequences for teachers to innovate in carrying out learning outcomes-oriented learning activities. This means that not only students learn to master some of the skills needed in the 21st century, but teachers must also have the ability to connect students with existing learning.

Science, Technology, Education, and Mathematics (STEM) Education has recently become the most trending issue in education. STEM education is considered to be able to overcome real problems that occur in society because it is able to create student become a problem solvers, inventors, innovators, independent, logical thinkers, technology literate, able to connect culture and history with education, and able to connect with the world of work (Morrison , 2006). STEM education applies learning that places scientific inquiry and the application of mathematics in the context of designing technology as a form of problem solving. But in everyday life, design and scientific inquiry are routinely used together as solutions to real-world problems (Sanders, 2009). Therefore, this shows that STEM Education is able to answer the cahllange of the industrial revolution 4.0 and 21st century learning.

The rapid development of science and technology is also a challenge that can be used to support the application of STEM Education in education. In addition, environmental and social issues such as global climate change are also important to be raised in the teaching and learning. Of course, integrating science, technology, society, and the environment requires complex and adequate knowledge. Therefore, to equip teachers with adequate technology, pedagogy, and content knowledge (TPACK) and skills in implementing STEM education, especially in integrating science, technology, society, and the environment, this workshop has been conducted.

1.2 Problems

Based on the above background situation, the formulation of the problems are:

1. How to improve inservice physics teacher TPACK in integrating science, technology, society, and environment of STEM Education?

2. What are the factors that support and hinder the implementation of the Physics teacher workshop in integrating science, technology, society, and environment in STEM Education?

1.3 Workshop Objectives

The objectives of this workshop are

1. Improving and fostering inservice physics teacher TPACK in integrating science, technology, society, and environment of STEM Education
2. Describing the supporting and inhibiting factors for the implementation of the Physics teacher workshop in integrating science, technology, society, and environment in STEM Education.

1.4 Workshop advantages

The advantages of this workshop are to provide information, insight and knowledge for researchers and high school physics teachers in integrating of science, technology, society, and environment in STEM Education. In addition, teachers will be equipped with abilities and skills in designing STEM learning, integrating technology and society in STEM learning, and STEM learning topics related to Climate Change Problems.

II. SOLUTION AND EXTERNAL TARGET

1.1 Solution Offered

The limited ability of inservice teachers in integrating science, technology, society, and environment in STEM education that is oriented towards 21st century curriculum is not only the responsibility of the school concerned, but is also a major issue that must be resolved by the government. Universities, especially the faculty of teaching and education, which are producers of educators must also take part in providing solutions to this problem.

Table 3.1. Problem Solving Framework

Recent Condition	Treatment/Process	Output
Inservice teachers still do not have sufficient knowledge and have not mastered the strategy of integrating science, technology, society, and environment in STEM education that is oriented towards the 21st century curriculum	Providing direct knowledge on how to integrate science, technology, society, and environment in STEM education that is oriented towards the 21st century curriculum	Increasing inservice teacher knowledge about how to integrate science, technology, society, and environment in STEM education that is oriented towards the 21st century curriculum
TPACK's Inservice teachers are still low in compiling STEM education components into learning units and design by integrating science, technology, society, and environment that is oriented towards the 21st century curriculum	Provision of skills directly through workshop and training and providing follow-up plans to develop learning units by integrating science, technology, society, and environment that is oriented towards the 21st century curriculum	Increasing TPACK's inservice teachers in integrating science, technology, society, and environment into STEM Education-based learning

Problems that arise due to the limited skills of TPACK inservice teachers in designing and compiling learning units in learning designs that contain components of STEM education by integrating science, technology, society, and environment can be found alternative solutions, namely through activities in the form of workshops related to unit preparation and learning design that leads to optimizing TPACK inservice teachers through STEM Education-based learning that is in line with the 21st century curriculum. Through this activity, it is hoped that all inservice teachers involved in this program have better TPACK skills in compiling a unit and learning design that is oriented towards learning objectives in the 21st century so that they can increase students' motivation and interest in learning Physics which has an impact on improving student learning outcomes.

1.2 Annual Output Target Plan

The planned annual achievement targets in this study are described in Table 2.1.

Tabel 2.1. Annual Output Target Plan

Output		Indicator
Mandatory output		
1	Scientific publications in international journals or journals with ISSN/Proceedings with ISBN	Accepted/published
2	Publication in print/online/repository PT	Draft
3	Increased competitiveness (improvement of quality, quantity, and added value of goods, services, product diversification, or other resources)	Product
4	Increasing the application of science and technology in society (mechanisation, IT, and management)	Product
5	Improvement of community values (art, culture, social, politics, security, peace, education, health)	Draft
Additional output		
1	Publications in International Journals	Draft
2	Services, social engineering, methods or systems, products/goods	Product
3	Intellectual property rights (Patent, Simple Patent, Copyright, Trademark, Industrial Product Design, Plant variety protection, Integrated circuit topographic design protection	Draft

1.3 Literature Review

The 21st century learning is learning that prepares the 21st century generation where the advancement of Information and Communication Technology (ICT) which is growing so fast has an influence on various aspects of life including the teaching and learning process. One example of the progress of Information and Communication Technology having an influence on the learning process is that students are given the opportunity and are required to be able to develop their skills in mastering information and communication technology - especially computers, so that students have the ability to use technology in the learning process that aims to achieve skills (Qazi et al., 2021). Integrating science, technology, society, and environment into learning and instruction processes is inevitable in this modern world, so it is of pivotal importance that all teachers should master Technological Pedagogical Content Knowledge (TPACK) confidently. Unfortunately, the approaches toward teacher education programs in many countries, specifically in Indonesia, do not yet integrate TPACK into the curriculum (Rahmadi, Hayati, & Nursyifa, 2020).

TPACK is a theoretical framework on the integration of coherent technology by teachers into their teaching (Oda, Herman, & Hasan, 2020). The framework (Figure 2.1) conceptualizes three major knowledge domains that intersect to form four interrelated knowledge domains with these main components. The three main domains are Knowledge Technology (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). The four intersecting domains are Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK).

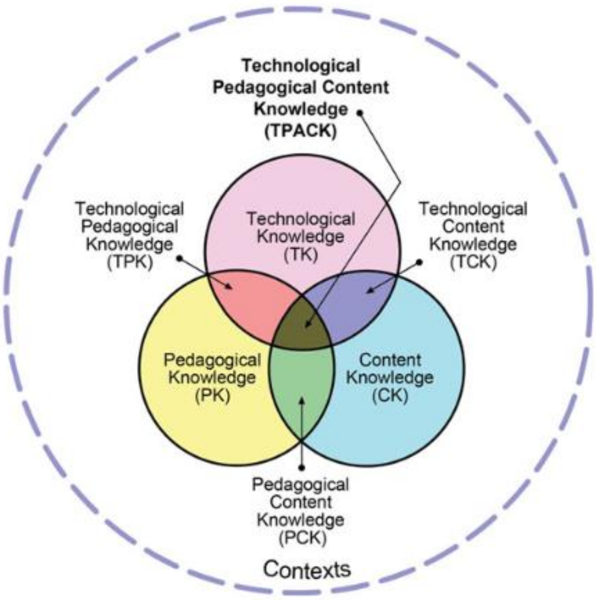


Figure 1. Technological Pedagogical Content Knowledge [Source: Oda, Herman, & Hasan (2020); Reproduced by permission of the publisher,@2012 by tpack.org]

Shulman (1987) originally proposed seven knowledge bases a teacher needs in order to create quality instruction: (i) CK, (ii) PCK, (iii) (general) pedagogical knowledge (PK), (iv) curriculum knowledge, (v) knowledge of learners and their characteristics, (vi) knowledge of educational context, and (vii) knowledge of educational ends, purposes, and values. The first three of these knowledge bases, CK, PCK, and PK, are presently widely considered to form the core of teachers' professional knowledge (van Driel et al., 2014). Among these knowledge bases, CK represents the knowledge of the subject matter; that is, knowledge about the academic content of the respective discipline, how this content is arranged into topics as well as how new knowledge within the discipline is constructed (Gess-Newsome et al., 2019; Shulman, 1986). In addition to CK, PCK is proposed as a knowledge that represents the “special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of understanding” (Shulman, 1987). PCK is the kind of knowledge that teachers draw on to make the content comprehensible for students (Shulman, 1986).

TPACK originated from an examination of Shulman’s (1986) study on pedagogical content knowledge (PCK). According to Shulman (1987), PCK “represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8). Teachers need to have a rich conceptual understanding of the material they teach. This rich conceptual understanding is combined with expertise in the development, use, and adaptation of teaching procedures, strategies, and approaches in particular classes. These skills are combined to form knowledge of content and pedagogy as defined by Shulman (1987). PCK is developed over time and through experience; it is considered to be a cornerstone of the craft of teaching (Loughran et al., 2012). This new understanding of the interaction between content and pedagogy has prompted educators to define a new technology-based knowledge form that was initially constructed by Mishra & Koehler (2006), as seen in Table 2.2 showed the constructs and definitions of the TPACK. In parallel with TPACK literature, research on pre-service teachers' technology integration knowledge and abilities has been limited (Chai et al., 2010). In addition, a limited number of studies have examined the effects of technology intervention on pre-service and in-service PE teachers' technology integration and TPACK variables (Agyei & Voogt, 2012; Chai, 2019).

Table 2.2. Brief Teachers Knowledge Constructs and Definitions of the TPACK (Mishra & Koehler, 2006).

Construct	Definition
Pedagogical Knowledge (PK)	"…knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims. This is a generic form of knowledge that is involved in all issues of student learning, classroom management, lesson plan development and implementation. It includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for evaluating student understanding." (p. 1026–1027)
Content Knowledge (CK)	"…knowledge about the actual subject matter that is to be learned or taught, including knowledge of central facts,

	concepts, theories, and procedures within a given field; knowledge of explanatory frameworks that organize and connect ideas; and knowledge of the rules of evidence and proof (Shulman, 1986).” (p. 1026
Technological Knowledge (TK)	“…knowledge of operating systems and computer hardware, and the ability to use standard sets of software tools such as word processors, spreadsheets, browsers, and email. TK includes knowledge of how to install and remove peripheral devices, install and remove software programs . . .” (p. 1027)
Pedagogical Content Knowledge (PCK)	“…exists at the intersection of content and pedagogy. Thus, it goes beyond a simple consideration of content and pedagogy in isolation from one another. PCK represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction.” (p. 1021)
Technological Pedagogical Knowledge (TPK)	“…knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies.” (p. 1028)
Technological Content Knowledge (TCK)	“…knowledge about the manner in which technology and content are reciprocally related. Although technology constrains the kinds of representation possible, newer technologies often afford newer and more varied representation and greater flexibility in navigating across these representations.” (p. 1028)
Technological Pedagogical and Content Knowledge (TPACK)	“…is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress

	some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge…" (p. 1029)

Contemporary education presents many challenges for improving the quality of teaching, including the knowledge of instructional practices of teachers in science, technology, engineering, and mathematics (STEM) disciplines. In order to improve the quality of teaching competencies for inservice teachers, the pedagogical content knowledge technology framework (TPACK) can be recognized and basically adopted. The importance of STEM education has been noted in preparing a new generation of workforce. Therefore, not only all students need stronger STEM education, but STEM teachers also need to educate and prepare themselves to gain high-quality teaching competencies in STEM disciplines. Today, it is important to increase the rigor of STEM teacher preparation and technology is playing an increasingly important role for the development of quality STEM oriented teachers (Kajonmanee et al., 2020).

Science, Technology, Engineering and Mathematics (STEM) are key subject matter knowledge that are interrelated. Among these subjects, engineering is in fact the cross disciplinary subject which integrates science and mathematics through design thinking to generate tools, products and processes to solve real-world problem (Chai et al., 2020). The outcome of the design processes can be broadly classified as technologies (Brophy et al., 2008; Chai, 2019). As mentioned above, one example of such technology is the mobile computing devices. The devices encapsulate myriad science and mathematical knowledge and they afford anywhere and anytime access to information, computation and communication. Technologies subsequently form the facilitating means for the advancement of scientific research, mathematical modelling and collective problem solving, which in turn drive new design through engineering efforts. The interrelated and reciprocal relationships between the STEM subjects imply that it is at least pedagogically sensible to consider the teaching of these subjects in an interrelated manner (Chai et al., 2020). In addition, the power to create advancement in technologies is vital for a society to stay economically competitive in the 21st century (Hoeg et al., 2017). Thus, education authorities are advocating 21st century STEM curriculum. An immediate and obvious pedagogical implication of 21st century STEM curriculum is the need to develop teachers who can foster deep understanding of STEM knowledge through engineering-oriented design knowing (English, 2017). There is therefore a clear need for teacher educators to articulate some form of theoretical frameworks to ground research in TPD for STEM education (Chai et al., 2020; Lee et al., 2014; Parker et al., 2015).

III. METHODOLOGY

3.1 Method and Stages of Program

Informative–participatory method was used in this community service program. This method requires physics teachers to have theoretical and practical insight on how to develop STEM learning that integrates science, technology, society, and environment in order to improve their TPACK. The stages carried out in this activity were in the form of information by the presenter, discussion, performance, and simulation.

3.2 Program Description

The workshop that will be carried out is an effort to give problem-solving solutions to overcome the obstacles experienced by Physics teachers in developing STEM learning that integrates science, technology, society, and environment with the following agenda.

No	Topics	Hours
1	Workshop Orientation	**2**
2	Introduction to STEM dan its activities	**2**
3	Utilization of android phone for hands-on physics pendulum	**2**
4	development of virtual lab worksheet to build higher order thinking skills	**6**
5	SEAQIS efforts in introducing STEM as a science learning innovation	**6**
6	STEM-based Physics learning	**6**
7	Do It Yourself Optics Experiment	**6**
8	Follow Up Plan	**2**
Total		**32**

3.3 Work Procedure

The work procedure in this program is that the participants are given material on STEM learning design, integrating science, technology, society, and environment into STEM learning, and STEM learning topics related to Climate Change

Problem. In the implementation of the workshop on STEM learning topics, participants are given the opportunity to do simulation as students, so they can understand well how the technical implementation of the STEM learning is. Hopefully, this can increase the TPACK owned by teachers.

3.4 Parties Involved

The parties involved in this community service program are high school physics teachers who are member of Musyawarah Guru Mata Pelajaran (MGMP) Fisika SMA/MA Kota Bandar Lampung, SEAMEO QITEP In Science, and SEA Teacher.

3.5 Partner Participation

The participation of partners, in this case Fisika SMA/MA Kota Bandar Lampung, is as a forum for providing information to high school physics teachers in Bandar Lampung. In addition, SEAMEO QITEP In Science, as a workshop resource.

3.6 Evaluation of Program Implementation and Sustainability

The evaluations of the program implementation are:

1) Initial evaluation

   The initial evaluation was carried out to determine the teacher's initial understanding of STEM learning

2) Evaluation during the workshop process

   This evaluation is carried out when the teacher carries out STEM learning topics that have been prepared by the resource person.

3) Final evaluation

   The final evaluation was carried out to determine the teacher's final understanding after participating in the workshop activities.

IV. PERSONNEL AND EXPERTISE

The expertise that must be possessed to solve problems that arise are learning, evaluation, and education experts. The names of the proposing team and a description of their respective expertise and duties are as follows:

1. Chief executive
   a. Name : Prof. Dr. Agus Suyatna, M.Si.
   b. Pangkat/Gol/NIP : Pembina Utana Madya/IVd/ 196008211985031004
   c. Occupation : Professor
   d. Subject Expertise : Science Education
   e. Faculty/Department : FKIP/Pendidikan MIPA
   f. Time : 6 hours/week
   g. Specific expertise : Science education
   h. Job Description : Prepare and make evaluation instruments, data analysis, and prepare activity materials

2. Executive member
   ` a. Name : Dr. Abdurrahman, M.Si.
   b. Pangkat/Gol/NIP : Penata Tingkat I/IIId/196812101993031002
   c. Occupation : Lektor
   d. Subject Expertise : Science Education
   e. Faculty/Department : FKIP/ Pendidikan MIPA
   f. Time : 6 hours/week
   g. Expertise : Science education
   h. Job Description : Prepare and make evaluation instruments, conduct literature review, and analyze data

3 Executive member
   a. Name : Dr. I Wayan Distrik, M.Si.
   b. Pangkat/Gol/NIP : Pembina Tingkat I/IVB/196312151991021001
   c. Occupation : Lektor Kepala

d.	Subject Expertise	:	Physics/ Physics Education
e.	Faculty/Department	:	FKIP/ Pendidikan MIPA
f.	Time	:	6 hours/week
g.	Expertise	:	Physics/ Physics Education
h.	Job Description	:	Prepare and make evaluation instruments, conduct literature review, and analyze data

4 Executive member

a.	Name	:	Hervin Maulina, S.Pd., M.Sc.
b.	Pangkat/Gol/NIP	:	-
c.	Occupation	:	-
d.	Subject Expertise	:	Physics/ Physics Education
e.	Faculty/Department	:	FKIP/ Pendidikan MIPA
f.	Time	:	4 hours/week
g.	Expertise	:	Physics/ Physics Education
h.	Job Description	:	Coaching inservice teachers to prepare teaching materials, and learning media

5 Executive member

a.	Name	:	Novinta Nurulsari, S.Pd., M.Pd.
b.	Pangkat/Gol/NIP	:	-
c.	Occupation	:	-
d.	Subject Expertise	:	Physics Education
e.	Faculty/Department	:	FKIP/ Pendidikan MIPA
f.	Time	:	4 hours/week
g.	Expertise	:	Physics Education
h.	Job Description	:	Coaching inservice teachers to prepare teaching materials, and learning media

V. RESULTS AND DISCUSSION

5.1 Results

The workshop results was in the form of teacher perceptions about integrating science, technology, society, and environment which is presented in Figure 5.1. (Details of each participant's score are presented in Appendix 1).

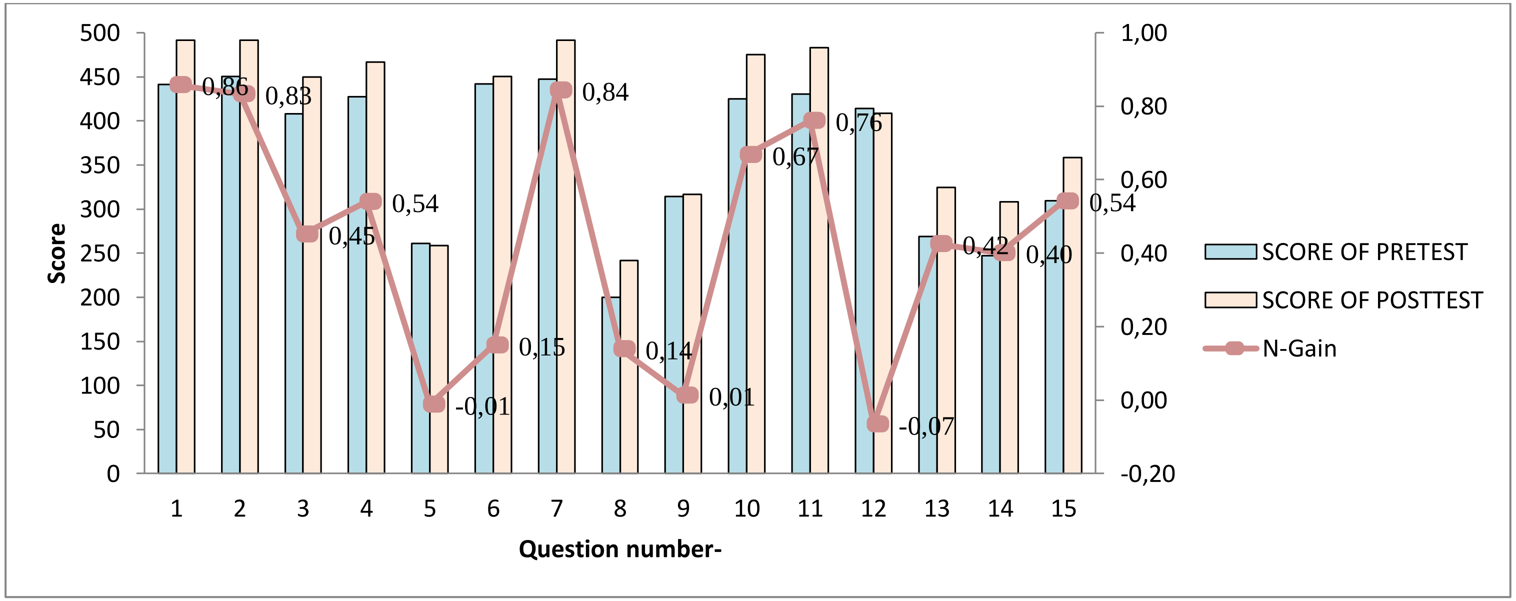


Figure 5.1 N-Gain score

5.2 Discussion

This workshop has been conducted both online and offline by involving participants from 3 countries in Southeast Asia, namely Indonesia, Malaysia, and Laos. In addition, this activity also invited speakers from Southeast Asian Ministers of Education Organization Quality Improvement of Teachers and Education Personnel (SEAMEO QITEP), Lintang Prastika, S.Pd., M.Sc. The material presented at this community service activity included the utilization of android phone for hands-on physics pendulum, SEAQIS efforts in introducing STEM as a science learning innovation, STEM-based Physics learning, development of virtual lab worksheet to build higher order thinking skills, and Do It Yourself Optics Experiment. Because it is still in a state of pandemic, this activity is carried out in two online and offline modes. The number of participants attending offline is limited to only 11 people to practice social distancing (Figure 5.2).

Figure 5.2. Participants and presenter who attend offline

Figure 5.3 Oral presentation by Prof. Dr. Agus Suyatna, M.Si.

The first material regarding the utilization of android phone for hands-on physics pendulum was delivered by Prof. Dr. Agus Suyatna, M.Si. (Figure 5.3). In the presentation of the material, various android-based applications were introduced. Participants who attended this activity offline were invited to do a hands-on experiment using one of the android applications, phypox.

Experiments carried out using the phypox application downloaded from the android playstore were air column resonance and calculating gravity using a pendulum experiment. Activity participants were asked to calculate air velocity based on experiments conducted by reading data based on data that appeared on the phypox application (Figure 5.4). At the end of speaker 1 session, a question and answer session was held with the participants. Some sample questions asked by participants are:

Question 1 : (G_Handono Suwarno_SMKN1Sepa) for pendulum experiment, we use hp as mass of pendulum,so we must know the mass/weight of hp?

Answer 1: In this experiment, no HP mass data is needed because to calculate gravity it does not depend on mass.

Question 2: (Intan Mulia S) to calculate frequency and period, what application is used?

Answer 2: Phypox will show the data calculated automatically in the screen.

Figure 5.4. Hands-on experiment using phypox application

The second presentation of the material was delivered by Dr. I Wayan District, M.Sc. regarding the development of virtual lab worksheet to build higher order thinking skills (Figure 5.5). In the second presentation, the use of a virtual lab application that can be used is simulated, namely PhET simulation. It was also explained that by using PhET simulation, various experiments that could not be presented directly could be done virtually by students. Therefore it takes student worksheets that are used as a complement in the virtual lab activities.

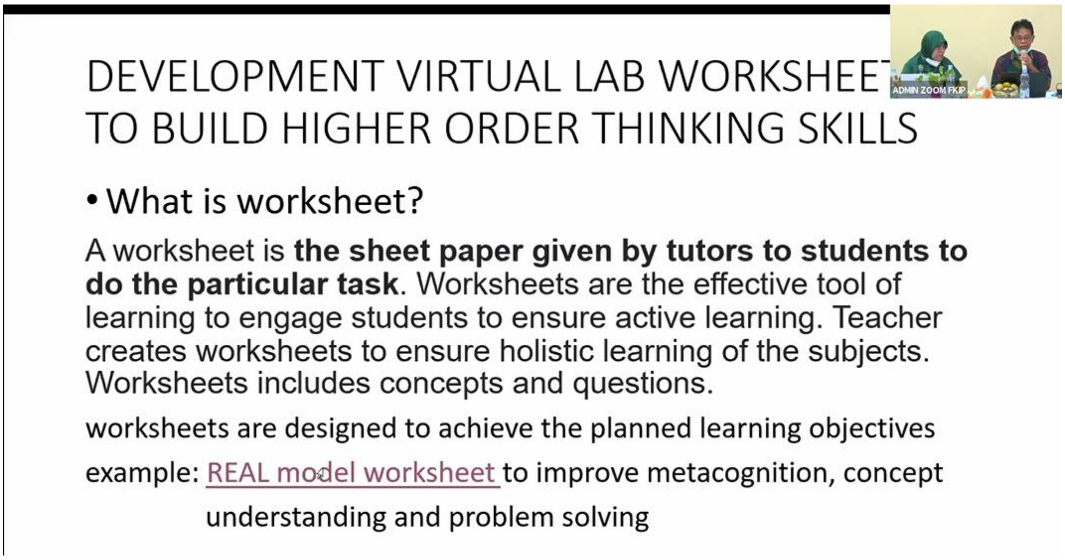


Figure 5.5. Pemaparan materi kedua oleh Dr. I Wayan distrik, M.Si.

In the discussion and question and answer session for material 2 there were several questions that were asked by the participants, including the following:

Question 1: (G_Handono Suwarno_SMKN1Sepa) problems in learning HOTS, at the level of education they experienced before, students were not accustomed to thinking higher, so that when directing students to think about HOTS they still hesitated, even more so when learning electricity, even though using an application program. what is the trick to open these barriers?

Answer 1: Teachers must be able to present learning that is able to stimulate step by step to achieve or direct students to think HOTS.

Question 2: (Amiruddin Takda FKIP UHO) before using phet, it should be preceded by a demonstration of real tools so that students can think for real.

Answer 2: True, virtual labs are used when live experiments are no longer possible.

The presentation of the material in session 3 was carried out by Lintang Prastika, S.Pd., M.Sc. regarding SEAQIS efforts in introducing STEM as a science learning innovation (Figure 5.6). The material presented is about the efforts that have been made by SEQIS in introducing STEM to the community, especially the world of education.

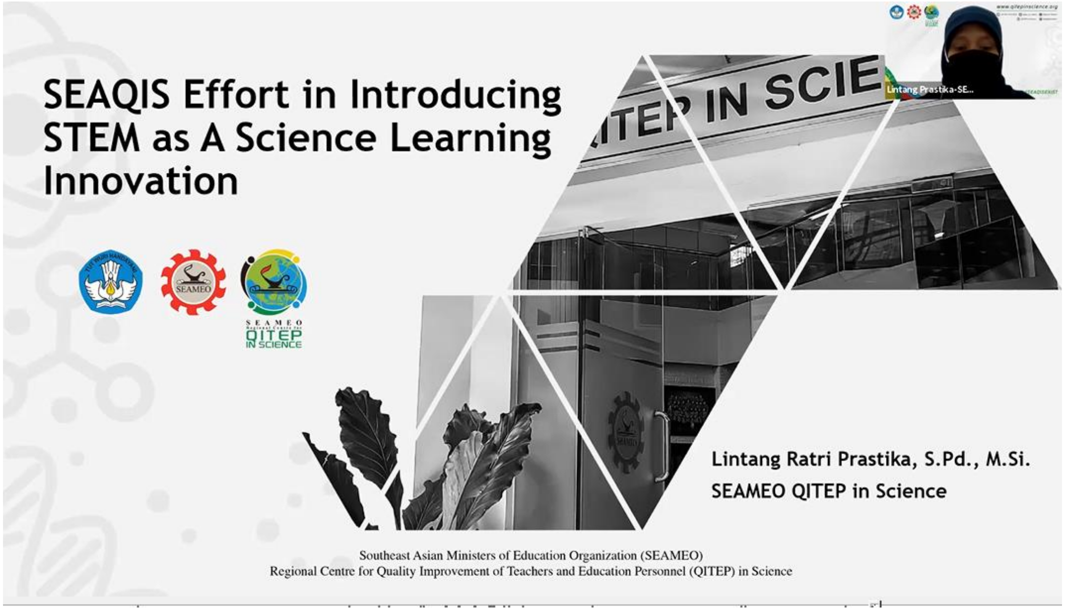


Figure 5.6. Lintang Prastika is introducing STEM as a science learning innovation

The presentation of the fourth material was delivered by Dr. Abdurrahman M.Si. on STEM-based Physics learning (Figure 5.7). It was conveyed by the speaker that in teaching STEM to students, teachers should be able to analyze the targeted learning outcomes and the basic competencies that have been determined. Participants who attended offline were also given the challenge to conduct an experiment on rigid body equilibrium (determination of center of gravity) (Figure 5.87). It is further emphasized that in instilling a concept so that students are able to remember well is to provide opportunities for students to be able to explore or try it themselves.

Figure 5.7. Presentation of the fourth material

Figure 5.8. Experiment in finding equilibrium point

The last presentation was delivered by Hervin Maulina, S.Pd., M.Sc. about Do IT Your Home Optics Experiment (Figure 5.9). In the presentation of this last material, the speaker gave reinforcement to the teacher to carry out simple experiments that could be carried out at the students' homes during online learning. The experiment can be carried out on the principle of using tools and materials that are easily available and low in cost. Participants who attended offline were also given the opportunity to carry out optical experiments to calculate the critical point in the water-air refraction event (Figure 5.10)

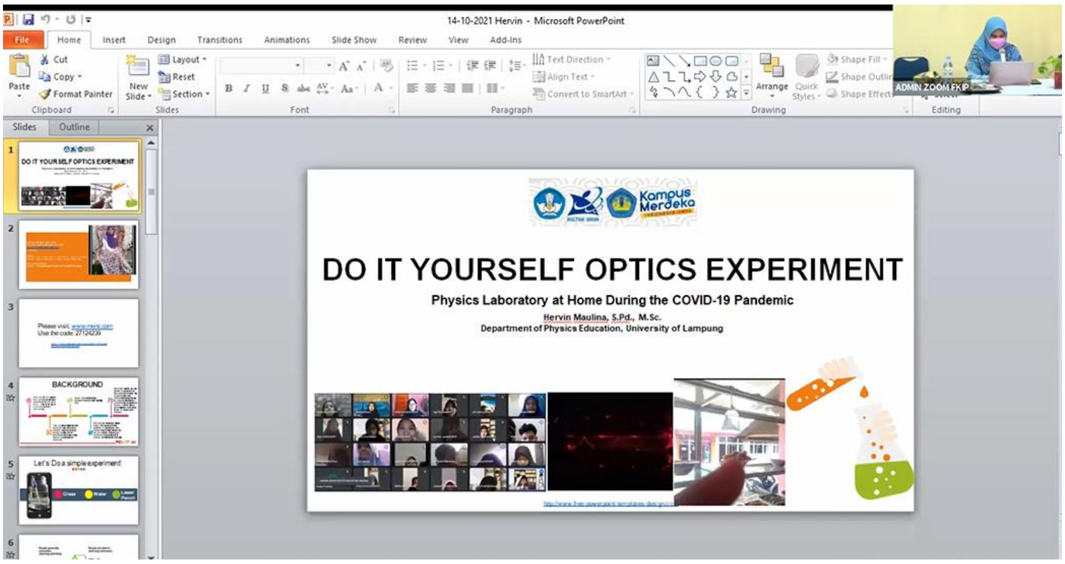


Figure 5.9. The last presentation about do it your self optics experiment

Figure 5.10. Experiment to determine the critical point on the phenomenon of water-air refraction

Before and after receiving the material, all participants are required to work on pretest/posttest questions which consist of 15 questions on a Likert scale regarding participants' understanding and perception of integrating science, technology, society, and environment in learning. Participants' pre-posttest results are presented in Figure 5.1. The results of the pretest and posttest showed an increase in participants' perception. This increase when analyzed based on the n-gain score was obtained at 0.38 or this increase was in the moderate trecategory. This indicates that the implementation of the activity has succeeded in increasing the understanding of participants in the moderate category. But, based on the data of Figure 5.1, there were 2 questions with negative n-gain score, there were question number 5 and 12. Question number 5 was about the implementation of the STEM approach in learning Physics must use advanced and expensive technology. It means that based on the participant there were decreasing of participant believed about to conduct STEM approach in physics learning must use advanced and expensive technology. This is a positive changing of participant's point of view. Beside that, based on the question number 12, there were decreasing of scores about higher order thinking skills can be trained through providing student worksheets. It was okay, because there were still many ways in building student's higher order thinking skills.

After the workshop, it can be known about the supporting and inhibiting factors for the implementation of the Physics teacher workshop in integrating science, technology, society, and environment in STEM Education. The supporting factors are the participants have been well known of technology and they have had supporting technology to conduct it. Beside the supporting factors, there was also the inhibiting factor. The biggest inhibiting factor was teacher don't have enough time in integrating science, technology, society, and environment in STEM Education especially during the covid-19 pandemic because of the limitation of time.

VI. CONCLUSION AND SUGGESTION

6.1 Conclusion

In improving inservice physics teacher TPACK (as a participant) in integrating science, technology, society, and environment of STEM Education can be conducted by doing such kind of workshop which clearly explain and provide experience for all the participants. Beside that, it can be known about the supporting and inhibiting factor for the implementation of the Physics teacher workshop in integrating science, technology, society, and environment in STEM Education respectly are knowledge & technology and the inhibiting factors are inservice teacher don’t have enough time to conduct it escpecially during pandemic covid-19.

6.2 Suggestion

Formal settings include conferences, courses, seminars, retreats and workshops about integrating science, technology, society, and environment in STEM Education should be held masively to give the opportunities for teacher professional development.

REFERENCES

Agyei, D. D., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. *Australasian Journal of Educational Technology*, *28*(4).

Brophy, S., Klein, S., Portsmore, M., & Rogers, C. (2008). Advancing engineering education in P-12 classrooms. *Journal of Engineering Education*, *97*(3), 369–387.

Chai, C. S. (2019). Teacher professional development for science, technology, engineering and mathematics (STEM) education: A review from the perspectives of technological pedagogical content (TPACK). *The Asia-Pacific Education Researcher*, *28*(1), 5–13.

Chai, C. S., Jong, M., & Yan, Z. (2020). Surveying Chinese teachers' technological pedagogical STEM knowledge: A pilot validation of STEM-TPACK survey. *International Journal of Mobile Learning and Organisation*, *14*(2), 203–214.

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Journal of Educational Technology & Society*, *13*(4), 63–73.

English, L. D. (2017). Advancing elementary and middle school STEM education. *International Journal of Science and Mathematics Education*, *15*(1), 5–24.

Gess-Newsome, J., Taylor, J. A., Carlson, J., Gardner, A. L., Wilson, C. D., & Stuhlsatz, M. A. M. (2019). Teacher pedagogical content knowledge, practice, and student achievement. *International Journal of Science Education*, *41*(7), 944–963.

Hoeg, D., Williamson, T., & Bencze, L. (2017). School science ruling relations and resistance to activism in early secondary school science. In *Science and technology education promoting wellbeing for individuals, Societies and environments* (pp. 49–66). Springer.

Kajonmanee, T., Chaipidech, P., Srisawasdi, N., & Chaipah, K. (2020). A personalised mobile learning system for promoting STEM discipline teachers' TPACK development. *International Journal of Mobile Learning and Organisation*, *14*(2), 215-235.

Lee, O., Miller, E. C., & Januszyk, R. (2014). Next generation science standards: All standards, all students. *Journal of Science Teacher Education*, *25*(2), 223–233.

Loughran, J., Berry, A., & Mulhall, P. (2012). Understanding and Developing

ScienceTeachers’ Pedagogical Content Knowledge (Vol. 12). Springer Science & Business Media.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054.

Oda, K., Herman, T., & Hasan, A. (2020). Properties and impacts of TPACK-based GIS professional development for in-service teachers. *International Research in Geographical and Environmental Education*, *29*(1), 40-54.

Parker, C. E., Stylinski, C. D., Bonney, C. R., Schillaci, R., & McAuliffe, C. (2015). Examining the quality of technology implementation in STEM classrooms: Demonstration of an evaluative framework. *Journal of Research on Technology in Education*, *47*(2), 105–121.

Qazi, A., Hardaker, G., Ahmad, I. S., Darwich, M., Maitama, J. Z., & Dayani, A. (2021). The Role of Information & Communication Technology in Elearning Environments: A Systematic Review. *IEEE Access*, *9*, 45539-45551.

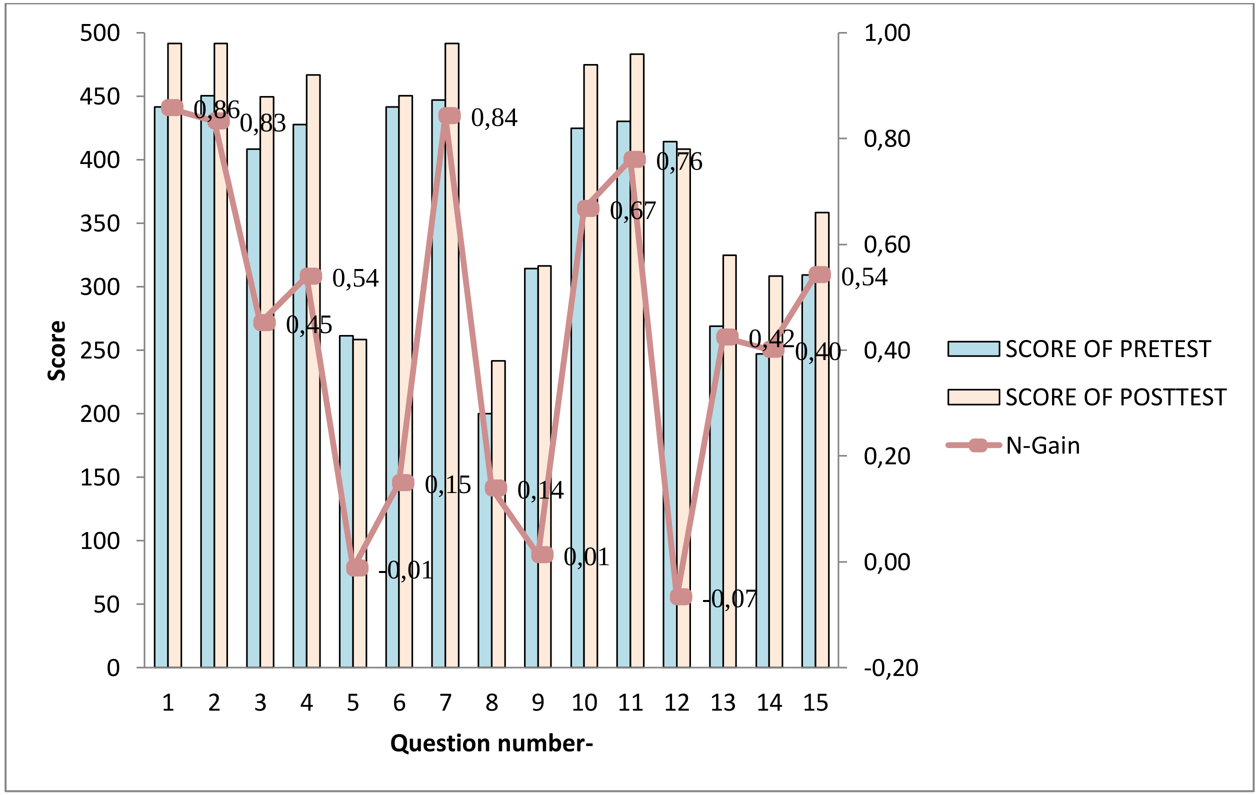
APPENDIX

RESULT

No	Questions	Respon PRETEST (%)					SKOR PRETEST	Respon PRETEST					SKOR POSTTEST	N-GAIN
		1	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**		
1	The characteristics of STEM integrated science learning are problem-based and engineering design process.	2,8	0	8,3	30,6	58,3	**441,6**	0	0	0	8,3	91,7	**491,7**	**0,86**
2	STEM learning can be integrated into extracurricular activities.	0	0	5,6	38,9	55,6	**450,4**	0	0	0	8,3	91,7	**491,7**	**0,83**
3	STEM can be integrated into all physics learning topics.	0	0	25	41,7	33,3	**408,3**	0	8,3	8,3	8,3	75	**449,7**	**0,45**
4	ICT is an integral component in learning Physics with a STEM approach	0	0	16,7	38,9	44,4	**427,7**	0	0	0	33,3	66,7	**466,7**	**0,54**
5	Implementation of the STEM approach in learning Physics must use advanced and expensive technology.	19,4	22,2	16,7	16,7	25	**261,3**	33,3	16,7	25	8,3	16,7	**258,4**	**-0,01**
6	STEM can be integrated with the local knowledge, behavior and technology of the community where students are living	0	0	11,1	36,1	52,8	**441,7**	0	0	16,7	16,7	66,7	**450,4**	**0,15**

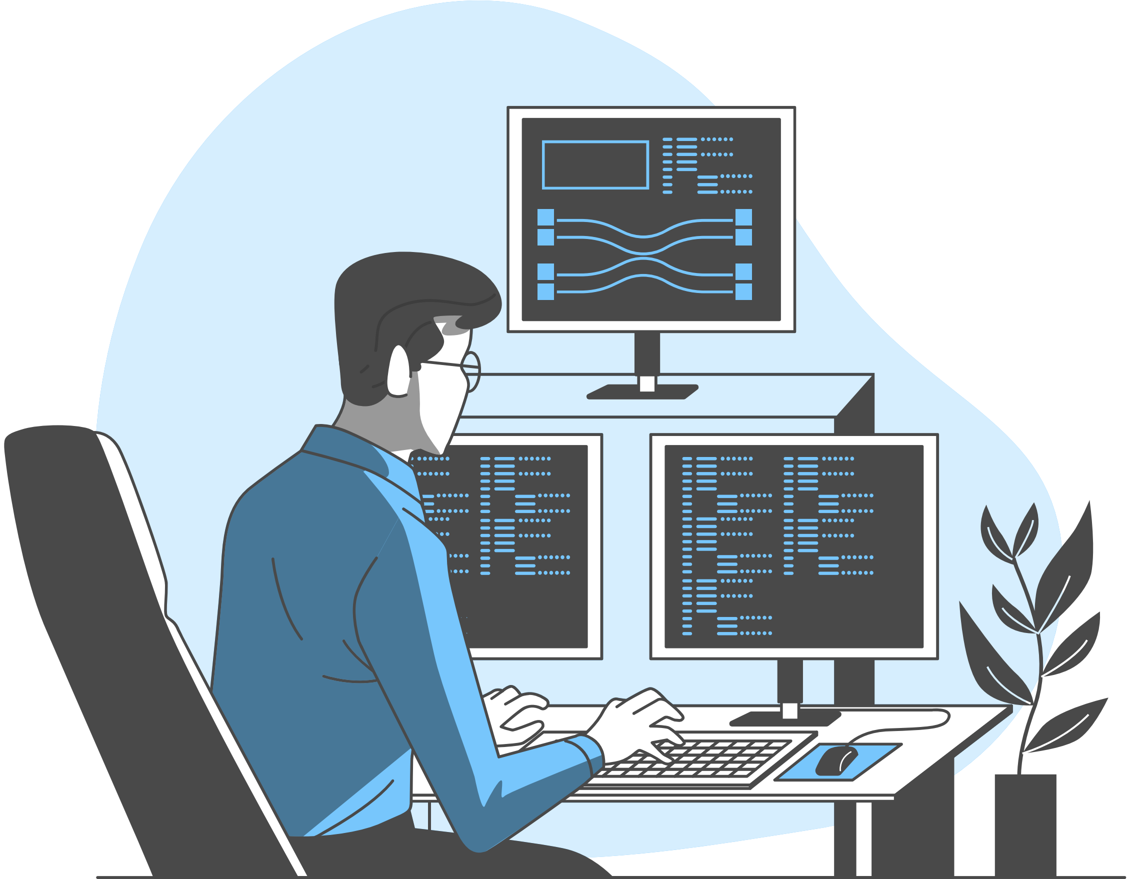
	(ethnoscience/ethnopedagogy)													
7	Practicum in physics has an important role in creating meaningful learning experiences and constructing concepts and theories for students	0	0	11,1	30,6	58,3	**447,2**	0	0	0	8,3	91,7	**491,7**	**0,84**
8	Physics practicum can only be carried out in the laboratory	22,2	33,3	16,7	11,1	16,7	**200,2**	50	8,3	8,3	16,7	16,7	**241,8**	**0,14**
9	Hands-on Physics practicum cannot be conducted during distance learning or during the Covid-19 Pandemic	16,7	27,8	25	13,9	16,7	**314,2**	16,7	25	8,3	25	25	**316,6**	**0,01**
10	Higher order thinking skills can make an individual able to interpret, analyze or manipulate the information obtained.	0	2,8	13,9	33,3	50	**424,9**	0	0	0	25	75	**475**	**0,67**
11	Higher order thinking skills not only require the ability to remember, but in practice, also require critical and creative thinking skills .	2,8	2,8	11,1	22,2	61,1	**430,4**	0	0	0	16,7	83,3	**483,3**	**0,76**

12	Higher order thinking skills can be trained through providing student worksheets	2,8	0	16,7	41,7	38,9	**414,2**	8,3	0	8,3	41,7	41,7	**408,5**	**-0,07**
		Don't know at all	**know a little bit**	**know enough**	**know a lot**			**Don't know at all**	**know a little bit**	**know enough**	**know a lot**			**0,42**
13	Knowledge of the use of android phone for hands-on physics practicum	2,8	44,4	33,3	19,4		**269,1**	0	8,3	58,3	33,3		**324,7**	**0,40**
		Have no skills	**slightly skilled**	**skilled enaough**	**skilled**			**Have no skills**	**slightly skilled**	**skilled enaough**	**skilled**			**0,54**
14	Skills in using android phone for hands-on physics practicum	8,3	47,2	33,3	11,1		**247**	0	16,7	58,3	25		**308,3**	**0,86**
		nothing	**only 1 topic**	**2-3 topics**	**more than 3 topoics**			**nothing**	**only 1 topic**	**2-3 topics**	**more than 3 topoics**			**0,83**
15	Number of android phone-assisted physics practicum topics that can be carried out at home	5,6	22,2	30,8	41,7		**309,2**	0	8,3	25	66,7		**358,4**	**0,45**



Score
Question number-
SCORE OF PRETEST
SCORE OF POSTTEST
N-Gain
0,86
0,83
0,45
0,54
-0,01
0,15
0,84
0,14
0,01
0,67
0,76
-0,07
0,42
0,40
0,54


INTERNATIONAL WORKSHOP ON STEM EDUCATION: INTEGRATING SCIENCE, TECHNOLOGY, SOCIETY, AND ENVIRONTMENT FOR FOSTERING INSERVICE TEACHER TPACK
Thursday, October 14th 2021
Gedung N Faculty of Teacher Training and Education, University of Lampung
FKIP UNILA
Featured Speakers
Prof. Dr. Agus Suyatna, M.Si. [Post Graduate Physics Education Department, University of Lampung]
Dr. Abdurrahman, M.Si. [Post Graduate Physics Education Department, University of Lampung]
Dr. I Wayan Distrik, M.Si. [Post Graduate Physics Education Department, University of Lampung]
Lintang R. Prastika, S.Pd, M.Si [Instructor of SEAMEO QITEP in Science]
Hervin Maulina, S.Pd., M.Sc. [Department of Physics Education, University of Lampung]
Novinta Nurulsari, S.Pd., M.Pd. [Department of Physics Education, University of Lampung]
International Research Grants
Faculty of Teacher Training and Education
University of Lampung



UTILIZATION OF ANDROID PHONE FOR HANDS-ON PHYSICS PRACTICUM

Prof. Dr. Agus Suyatna, M.Si
Graduate Physics Education Department
Universitas Lampung, Indonesia

NIDN : 0021086003

Scopus
H-Index : 5
Document: 27

Google Scholar
H-Index : 16/35
Document: 1.265

PHYPHOX
(Physical Phone Experiment)

1 **Raw Sensors**

2 **Acoustics**

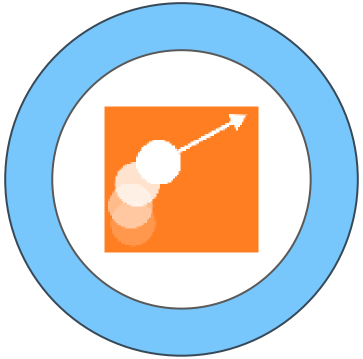
3 **Everyday Life**

4 **Mechanics**

5 **Timers**

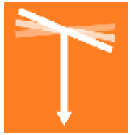
6 **Tools**

01
Raw Sensor



Acceleration (Without g)

Get raw data from the so called linear accelerometer, which gives the actual acceleration without the gravitational acceleration. In contrast to “acceleration with g”, this sensor reports 0 when the device is resting.



Acceleration (With g)

Get raw data from the accelerometer. This sensor will not subtract the gravitational force, so it will report an acceleration of 9,81 m/s^2 even when the phone is resting.

...

Location (GPS)

Get raw position data from satellite navigation.
Note that the available data may depend on the implementation on your smartphone. Some devices may not provide vertical accuracy or the number of satellites.
Also, by default there is location information from other typically less accurate sources (like wifi or mobile data networks) mixed into the data from satellite navigation.
Again, depending on your device, you may be able to disable these sources from the experiment menu by enabling the setting to only collect data from satellite navigation.
Speed and direction are typically given by the device and are based on two or more consecutive position fixes.

Magnetometer

- Get raw data from the magnetometer.
- The magnetometer is quite sensitive as it is designed to measure the earth's magnetic field to act as compass.
- However, it is always exposed to internal fields from the electronics in your phone, which lead to incorrect results.
- Therefore phyphox tries to get the calibrated magnetic field from the system. In some cases, you might not get any data, if it is not yet calibrated (for example after the phone has just started).
- In this case you should rotate your phone a few times while the experiment is running. This helps the system to calibrate the sensor.
- Do not expose your phone to strong magnetic fields!

Raw Sensors

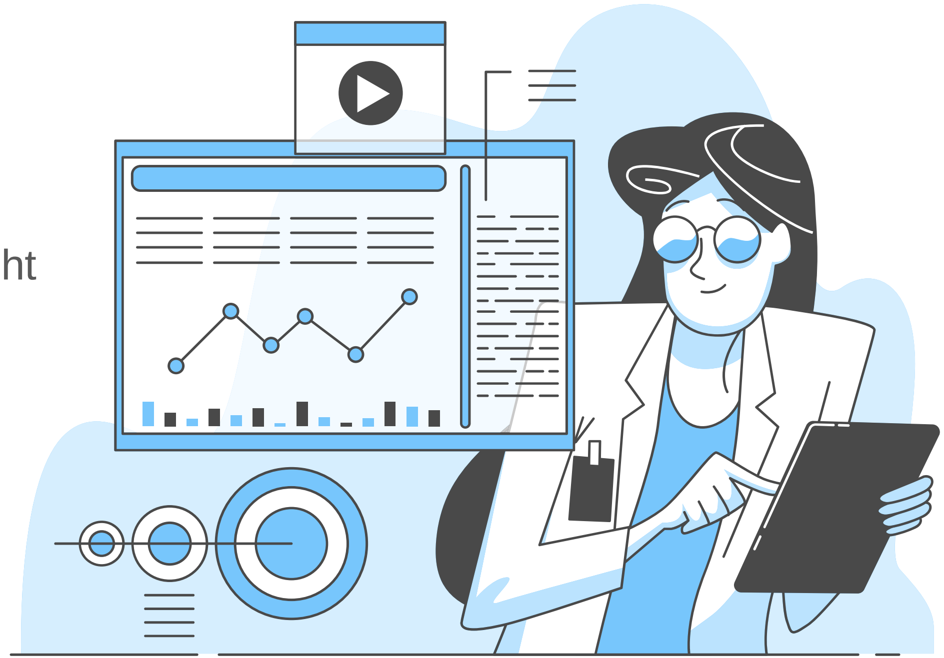
Gyroscope (Rotation Rate)

Get raw data from the gyroscope.

Light

Get raw data from the light sensor.

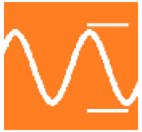
Pressure



02

Acoustics

Audio Amplitude

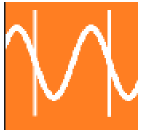


- Get the amplitude of sounds.

- This experiments simply records short intervals from the microphone and calculates the sound pressure level (SPL).
- Note that this calculation is a very naïve approach and the results may be rather imprecise.
- Also, you will have to give a reference to calibrate the

… measurement.

Audio Autocorrelation



Measure the frequency of a single tone.

This experiments records audio from the microphone and analyses it for its frequency. This only works if there is a single tone with a fixed frequency – if there are multiple frequencies (like an accord), use the “spectrum” experiment instead.

The analysis is done by calculating the autocorrelation of the audio signal. The experiment than considers all peaks that exceed half of the maximum signal in the autocorrelation. The position of the last of these peaks within the autocorrelation gives a multiple of the period of the signal. By counting the number of peaks we can get the period of the base frequency.

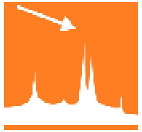
Audio Scope

Show recorded audio data.

This experiment just records short periods of audio data and displays them. To achieve a steadt image, a zero crossing is used as a trigger and t=0 is shifted to the first (positive) crossing.

...

Audio Spectrum



Displays the frequency spectrum of an audio signal.

This experiment records audio from the microphone and calculates its frequency spectrum through a Fourier Transformation (FFT). If you only have a single tone with a single frequency, you might get more precise results from the "autocorrelation" audio experiment.

...

Doppler Effect

- Detect small frequency shifts of the Doppler effect.

- You need a tone generator that emits a constant frequency (for example 1000Hz).
- Enter this base frequency in the experiments setup and select a detection range in which you expect the Doppler shifted frequency (for example 10Hz). The experiment will determine the recorded frequency and calculate the relative speed of the sound source.

Frequency History

Measure the frequency change over time for a single tone.

This experiment records audio from the microphone and analyses it for its frequency over short periods of time.
This only works if there is a single tone with a fixed frequency as it uses autocorrelation. The result will be plotted as a frequency over time.
…

Sonar

Measures distance through echoes and the speed of sound.

A sonar sends bursts of short sounds, which get reflected by the object you want to measure. As sound travels at a speed of approximately 340 m/s, the time until the reflection reaches the microphone of your phone can be used to calculate the distance of this object.

This experiments generates a “chirp”, sends it out through the speaker and starts a recording. A crosscorrelation of the chirp and the recorded data gives information about the timing at which echoes occur.

This timing can then be multiplied with the speed of sound (and deivded by 2 as the sound has to travel forth and back) and you get the distance at which the echo originated.

However, sound usually travels in every direction. For a sonar this means, that when targeting a wall, you also get reflections from the floor, the ceiling, another wall nearby, a post and simply from every suitable “hard” surface nearby. Therefore this sonar gives you all the reflections and it is up to you to interpret the result and to figure out, which reflection corresponds to the target you intended to measure. So start with a small hard target and try to screen all other directions with some foam material. Also this needs a quiet environment.

Tone Generator

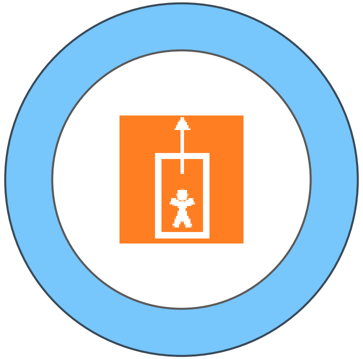
Generates a tone of a specific frequency

…

03

Everyday Life

Elevator



Determine the speed of an elevator using barometer

...

Appaluse Meter

Assign scores to length and amplitude of an applause.

This experiment integrates the amplitude of sound over time and assigns scores. This way a loud and long applause gets the higher score. You can evaluate multiple contestants and compare their performance in the bar chart.

Usage: The history shows the noise level detected by phyphox. You can start the scoring by pressing “start” and stop the scoring by pressing “stop”. During this period you will see the score increasing which is also indicated by the yellow bar. After stopping, you can press “next contestant” to get ready for measuring the next score. When you press “start” again, a second bar will grow until you press “stop” again. You can repeat this as often as you like to compare multiple scores.

04
Mechanics

(In)elastic Collision

Determine the energy lost during (in)elastic collisions of bouncing ball.

In principle, this experiment works like the acoustic stopwatch experiment. However, this experiment expects the sound to come from a ball (or something similar) bouncing on a surface and will calculate the bouncing height and remaining kinetic energy relative to the first bounce by analyzing the interval between the sound from the impact.

Also, by assuming that the ball retains the same percentage of kinetic energy on its first bounce, phyphoc will calculate the initial height 0 from which the ball is dropped.

So, start the experiment and let a ball bounce of a surface in a way that it generates a clearly hearable noise. You might want to change the threshold in the settings (in the range 0 to 1), so that the experiment reacts to the noise level of the ball but not to the background noise. Also, if you struggle with echoes, you might want to change the minimum delay as well to set the minimum interval the experiment will ignore before reacting to the next noise.

Centripetal Acceleration

Visualizes the centripetal acceleration as a function of angular velocity.

This experiment calculates the absolute value of the angular velocity ω from the gyroscope as well as the absolute acceleration a from the accelerometer. By plotting a against ω the relation a= $r \cdot \omega^2$ can be shown easily, hence plotting against ω^2 should result in a straight line.

To see this, you need to measure at different angular velocities but at a fixed radius. A salad spinner or a small carousel work great,

Pendulum

Determine the gravity constant (g = 9,81 m/s^2) by using your phone as a pendulum.
This experiment uses the gyroscope to measure the pendulum movement and calculates the oscillation period T. The user has to enter the length L of the string used for the pendulum, so phyphox can calculate
g = $4\pi^2 L/T^2$.

Alternatively, instead of measuring g, you can use the tab length and assume g = 9,81 m/s^2 to determine the length of the string from the pendulum motion. (Actually it's the distance from the pivot point to the center of mass.)

Additionally, on the resonance tab, it plots the amplitude against the detected frequency. This way, you can construct a driven oscillator and change its frequency to measure a resonance curve.

Further details:

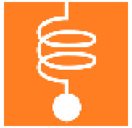
The oscillation period is obtained through the autocorrelation of the sum of all three gyroscope components. The autocorrelation is then analyzed for its first maximum for a first estimate and then the last maximum of the autocorrelation is used to get a more precise result.

Roll

Place your phone in a roll and determine its velocity.

You should place your phone in a paper roll so that it rotates about its longest side. This experiment then takes the angular velocity measured by the gyroscope as well as the radius of the roll to calculate the speed at which the roll travels.

Spring



Analyze the frequency and period of a spring oscillator.

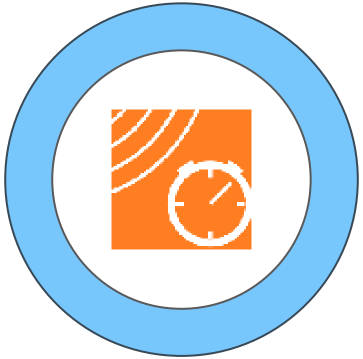
This experiment uses the accelerometer to measure the oscillator movement and calculates the oscillation period T. Additionally, on the resonance tab, it plots the amplitude against the detected frequency. This way, you can construct a driven oscillator and change its frequency to measure a resonance curve.

Further details :

The oscillation period is obtained through the autocorrelation of the sum of all three accelerometer components. The autocorrelation is then analyzed for its first maximum for a first estimate and then the last maximum of the autocorrelation is used to get a more precise result.

05

Timers

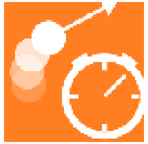


Acoustic Stopwatch

Get the time between two acoustic events.

This experiment allows to measure the time between two loud acoustic signals. These can be clicks, beeps, claps etc. as long as they are louder than the environment. You might want to adjust the threshold, giving the level at which the stop watch is triggered (ranging from 0 to 1).

After starting the experiment, the clock will start on the first noise exceeding the threshold and will be stopped on the second noise. To repeat the experiment, clear the data and start again. Make sure that the first noise is short as a long sound might be immediately detected as a stop.

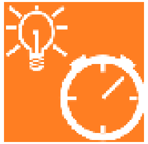


Motion Stopwatch

Get the time between two motion events.

This experiment allows to measure the time between two accelerations (like small shocks). You might want to adjust the threshold, giving the level at which the stop watch is triggered.

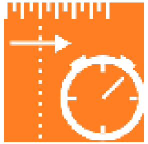
After starting the experiment, the clock will start on the first (total) acceleration exceeding the threshold and will be stopped on the second acceleration. Make sure that the first acceleration signal is short as a long vibration might be immediately detected as a stop.



Optical Stopwatch

Measure times based on the light shining onto your phone.
In this experiment you can expose your light sensor to a light source to measure the time between or the duration of bright or dark states. For example, you could measure the time between two events blocking a light source.

Note, that the precision depends strongly on the light sensor in your phone. For slow sensors this can easily be more than a second while fast sensors usually do not get faster than tenths of a second. Faster measurements can be achieved using the acoustic stopwatch experiment, which is based on sounds.



Proximity Stopwatch

Measure times based on the proximity sensor.
In this experiment you bring an object close to your proximity sensor (usually located at the front next to the speaker used for phone calls) and measure the times when the object is close to or far away from your phone.

Note, that the precision depends strongly on the proximity sensor in your phone. For slow sensors this can be easily be worse than a second while fast sensors usually do not get faster than tenths of a second. Faster measurements, but based on sound, can be achieved using the acoustic stopwatch experiment.

06
Tools

Acceleration Spectrum

Display the frequency spectrum of data from the accelerometer.

This experiment records data from the accelerometer and calculates its frequency spectrum through a Fourier Transformation (FFT). The maximum detectable frequency depends on the maximum acquisition rate of your sensor.

Inclination

Measure the angle of the phone’s inclination.

This tool uses the accelerometer to determine the inclination of the phone. When the phone is resting on a table, the inclination is zero. For non-zero inclination, the direction of the inclination is given as rotation.

Note, that the definition of the angles has been chosen for the task of measuring an inclination (especially for inclined plane experiments) independent of the rotation (about the z axis) of the phone.

Magnetic Spectrum

Display the frequency spectrum of data from the magnetometer.

This experiment records data from the magnetometer and calculates its frequency spectrum through a Fourier Transformation (FFT). The maximum detectable frequency depends on the maximum acquisition rate of your sensor.

Magnetic Ruler

Use a series of magnets to measure distance, speed and acceleration of the phone.

For this experiment you should place a series of identical magnets along the track the phone will travel. The distance between the magnets has to be the same for each magnet and should be entered in the experiment. The phone will then use its magnetometer to determine when it has passed a magnet, allowing to calculate the total distance covered.

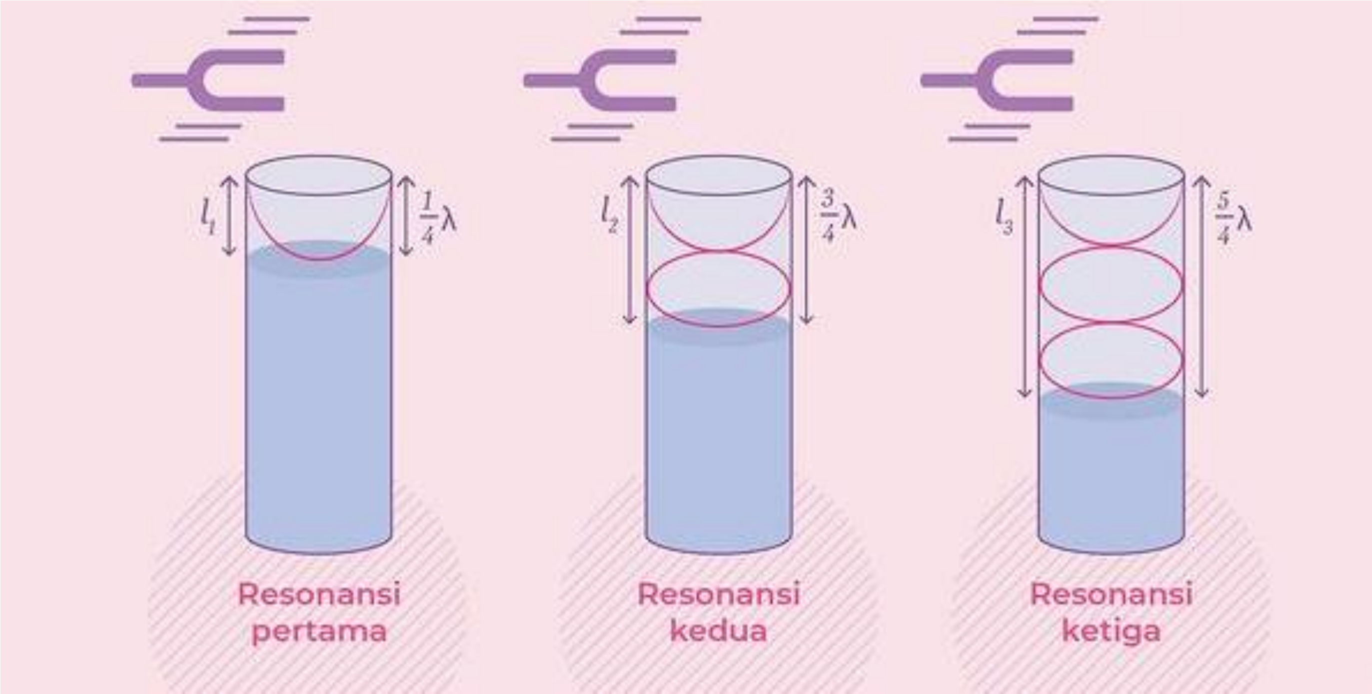
Let's do an experiment

Menentukan kecepatan bunyi di udara

Pendahuluan:

- Resonansi bunyi merupakan peristiwa **ikut bergetarnya suatu benda akibat getaran yang dihasilkan oleh sumber bunyi**.
- Resonansi bunyi hanya dapat terjadi jika suatu benda memiliki **frekuensi alami** yang **sama dengan frekuensi alami sumber bunyi** yang bergetar.
- **udara** atau **gas** di sekitar sumber bunyi **juga dapat beresonansi**, **asalkan memiliki frekuensi alami yang sama dengan frekuensi alami sumber bunyi**.
- Resonansi bunyi dapat **memperkuat bunyi asli**, sehingga bunyi yang dihasilkan dapat terdengar lebih keras dan nyaring.
- Resonansi terjadi ketika panjang kolom udaranya sebesar $\frac{1}{4}\lambda$, $\frac{3}{4}\lambda$, $^{5}/_{4}\,\lambda$ dan seterusnya, dengan selisih $\frac{1}{2}\lambda$ dari resonansi satu ke resonansi berikutnya

Kecepatan rambat bunyi di udara $v = \lambda f$



Dapatkah kita menentukan kecepatan bunyi di udara berdasarkan resonansi bunyi di dalam kolom udara? Bagaimana caranya?

Gunakan:

- HP sebagai sumber bunyi dengan tone generator
- Pipa paralon sepanjang 60 cm sebagai kolom udara
- Air dalam botol untuk mengatur panjang kolom udara

Bagaimana prosedurnya?

Lakukan percobaan, lengkapi tabel ini

f (Hz)	Ulangan ke i	L1(m)	L2(m)	L1 - L2	λ = 2L	$v = \lambda f$
1.250	1					
	2					
	3					
Rata-rata						

f (Hz)	Ulangan ke i	L1(m)	L2(m)	L1 - L2	λ = 2L	$v = \lambda f$
1.500	1					
	2					
	3					
Rata-rata						

f (Hz)	Ulangan ke i	L1(m)	L2(m)	L1 - L2	λ = 2L	$v = \lambda f$
1.700	1					
	2					
	3					
Rata-rata						

Menentukan percepatan gravitasi

Pendahuluan:

- Perioda ayunan pendulum dipengaruhi oleh panjang tali dan percepatan gravitasi bumi.
- Diformulasikan: $g = \frac{4\pi^2 L}{T^2}$
- Determine the gravity constant (g = 9,81 m/s^2) by using your phone as a pendulum.
- This experiment uses the gyroscope to measure the pendulum movement and calculates the oscillation period T.

Diskusikan

Percobaan apa lagi yang dapat dilakukan dengan memanfaatkan HP Android dengan alat tambahan yang ada di rumah?

Thanks!

SEAQIS Effort in Introducing STEM as A Science Learning Innovation

Lintang Ratri Prastika, S.Pd., M.Si.

SEAMEO QITEP in Science

Southeast Asian Ministers of Education Organization (SEAMEO)
Regional Centre for Quality Improvement of Teachers and Education Personnel (QITEP) in Science

SEAQIS

SEAMEO Regional Centre for Quality Improvement of Teachers and Education Personnel (QITEP) in Science
Established on 13 July 2009

Southeast Asia Ministers of Education Organisation (SEAMEO) established in Bangkok on 30 November 1965.

SEAQIS is one of 26 regional SEAMEO Centers in Southeast Asia, with focus on improving the professional competence of teachers and education personnel in the field of science.

Professional Teacher Development

Learning Resources Development

Professional Learning Communities

Programme Thrusts

www.qitepinscience.org

SEAQIS STEM PROGRAMME

SEAQIS STEM Programme Development Timeline

01

2015: Consolidation, coordination and cooperation

With ISTIC-UNESCO, ATSE Australia, AIPI, and UNESCO Bureau of Science for Asia-Pacific Region

02

2016-2017: Socialization

Started to socialize the STEM Education to the MOEC of Republic of Indonesia

03

2018 - 2019: implementation of STEM in the 2013 curriculum

STEM literature review, 2013 curriculum review, developing STEM training material, conducting STEM training for teachers.

04

2020 - present

Integrated STEM with local context, collaborating STEM with Computational Thinking (in developing process)

STEM Programme Promotion Strategies

STEM Integration into National Curriculum

Based on Project Based Learning
Focus on Engineering Design Process

Teacher professional competence development

By involving Teacher Association conducting teacher training

Collaboration

With Policy maker, MOEC units, Education Office in Region of Indonesia

Publication

Teacher and student competition
STEM Seminar
STEM Expo

STEM Programme and Activities

1. Workshop on Developing STEM Training Programme and Training Materials.
2. STEM Learning Unit Development
3. Training on STEM Integration into 2013 Curriculum.
4. Research grant for STEM implementation at Schools
5. Online Seminar: STEM Education
6. Assistance in implementing STEM in schools

Development of Training Materials

STEM Programme Book and STEM Material Book

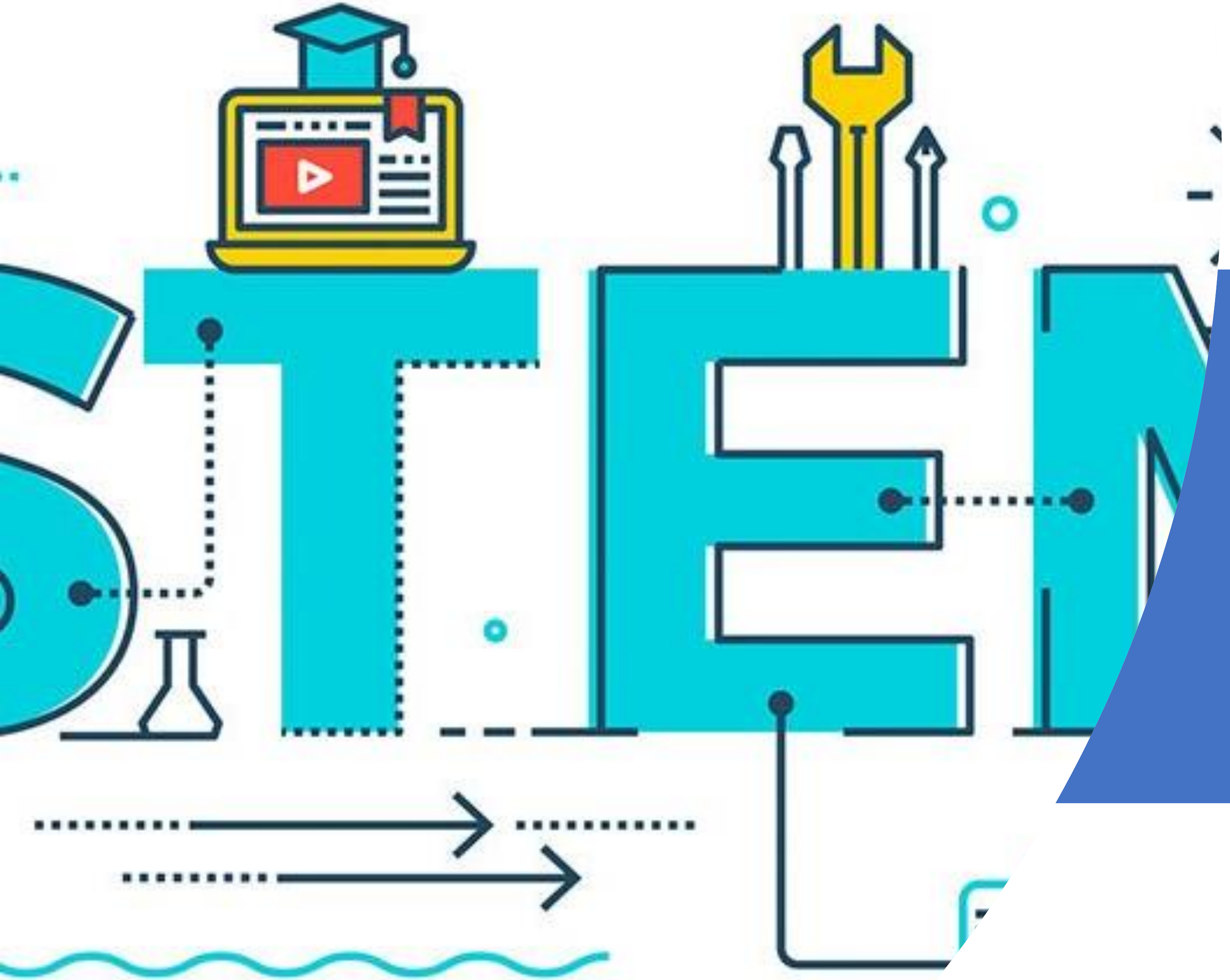
STEM Units and STEM Activity Book

What have we learned?

What is STEM?

STEM Characteristics

STEM Implementation in Science Learning



What is STEM??

SCIENCE
Observing, experimenting, making prediction, asking question

TECHNOLOGY
Being inventive, using tools, making things work, identifying issues, using computers

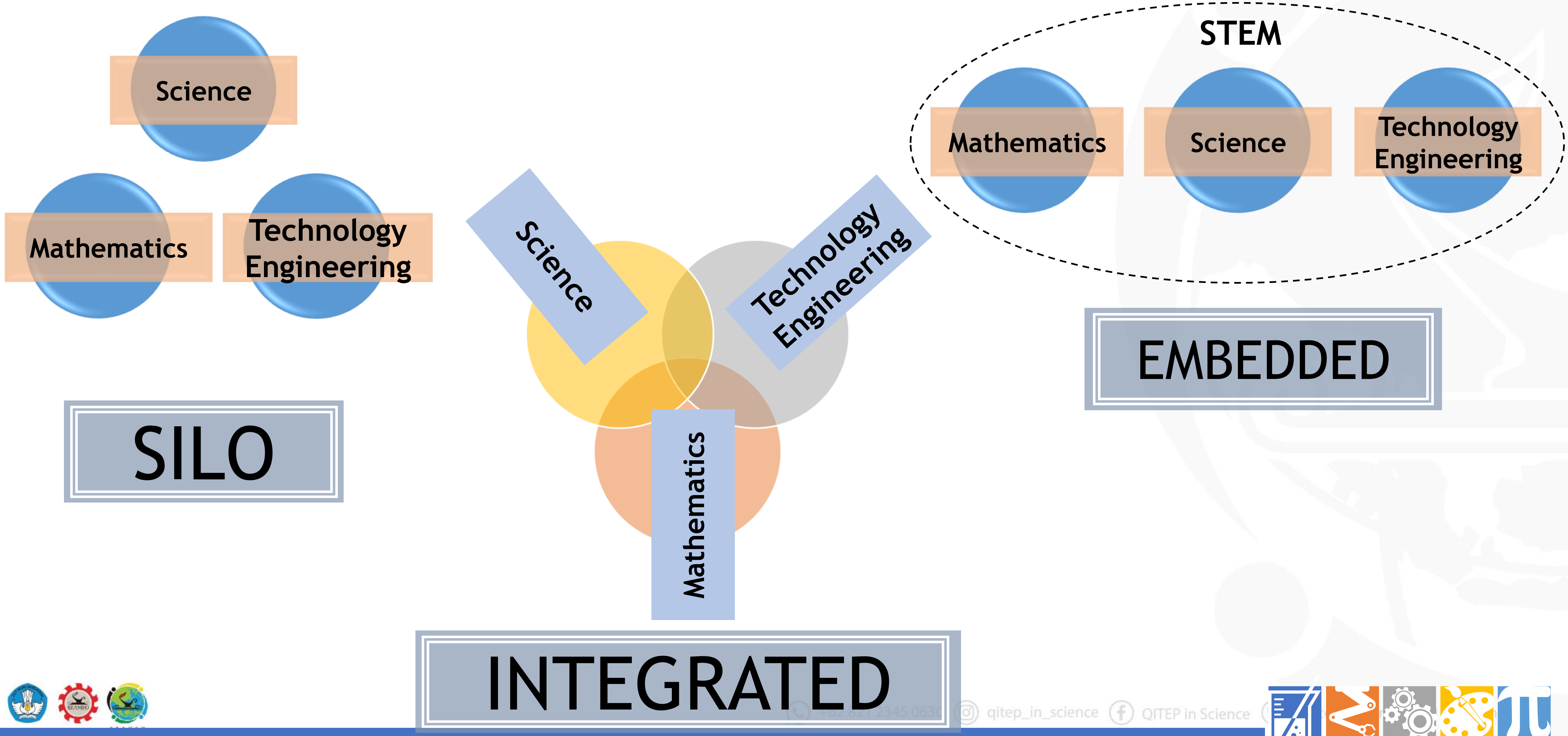
ENGINEERING
Solving problems, using materials, designign adn creating, building

MATHEMATICS
Pattering, squencing, exploring shapes, numbers, volume and size

STEM Learning

- STEM is a **learning approach** which **integrate** the four subjects (science, technology, engineering, and mathematics) that focuses on **solving problems** in real daily life and in professional life.
- STEM-based learning shows students how concepts, principles, and technics of science, technology, engineering and mathematics are used in an integrated manner to **develop products, processes and systems that are beneficial to human life**.

Variation of STEM Integration Models



Why STEM is Important?

Transformation of the educational process
Campos et. All, 2000

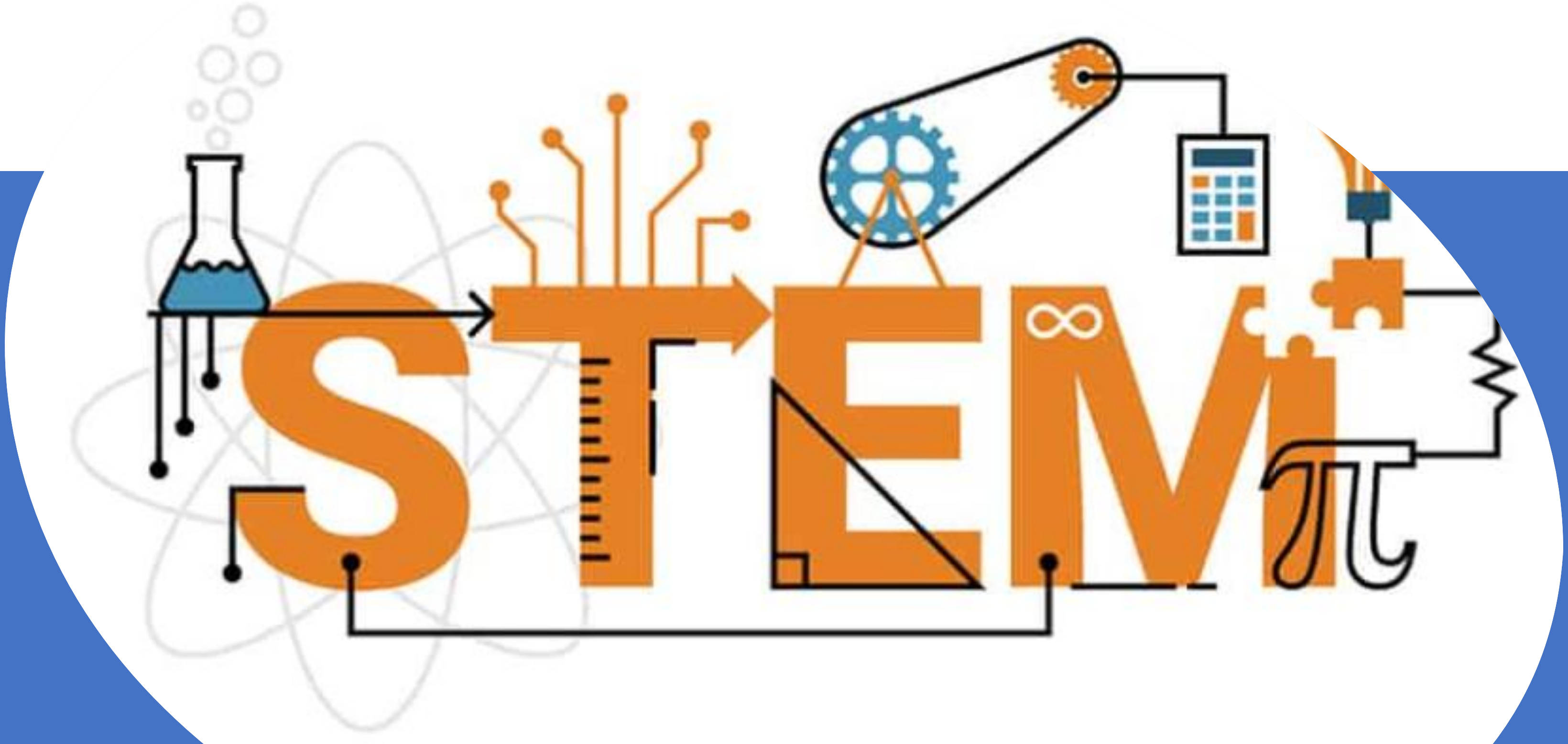
Answering the Technology Challenges
Campos et. All, 2000

Improved scientific understanding skills
Bao et. All, 2009.

The key in Innovation progress
Watt et. All, 2007

Human Resources Development
Kuenz, 2008.

Important for well-being, regarding to the STEM future job
Sanders, 2009



STEM

Characteristics

problem solving

Engineering Design Process
(EDP)

Problem Category

- **Problem Situation (early introduction to STEM)**
- **Contextual issues - *Local Context* issues (advance)**

Solved by Engineering Design Process

Example of problem situations in STEM learning

Earthquakes, volcanic eruptions, and flash floods are quite common in the Asia Pacific region. Disasters that are very destructive will make many people affected, such as losing their homes, families, getting injured, etc.

As a form of solidarity, all countries mutually give life supply, such as food, cloth, medicine, etc. to disaster victims.

Unfortunately, sometimes the supplies are hampered in distribution due to a shortage of personnel and difficulty in reaching the evacuation area.

One solution that can be done is to send the supplies by air.

Challenge

- How can we deliver the supplies to a disaster area by air without destroying the supplies when it arrives on the ground?

Example of Contextual Problems

- School waste management → Compost
- Turbid water treatment → Creating the water filtering tool
- Marine area → Making the water purification equipment/making food from sea product
- Areas near rivers with heavy flow → constructing micro hydro power plant

Solved by using the EDP

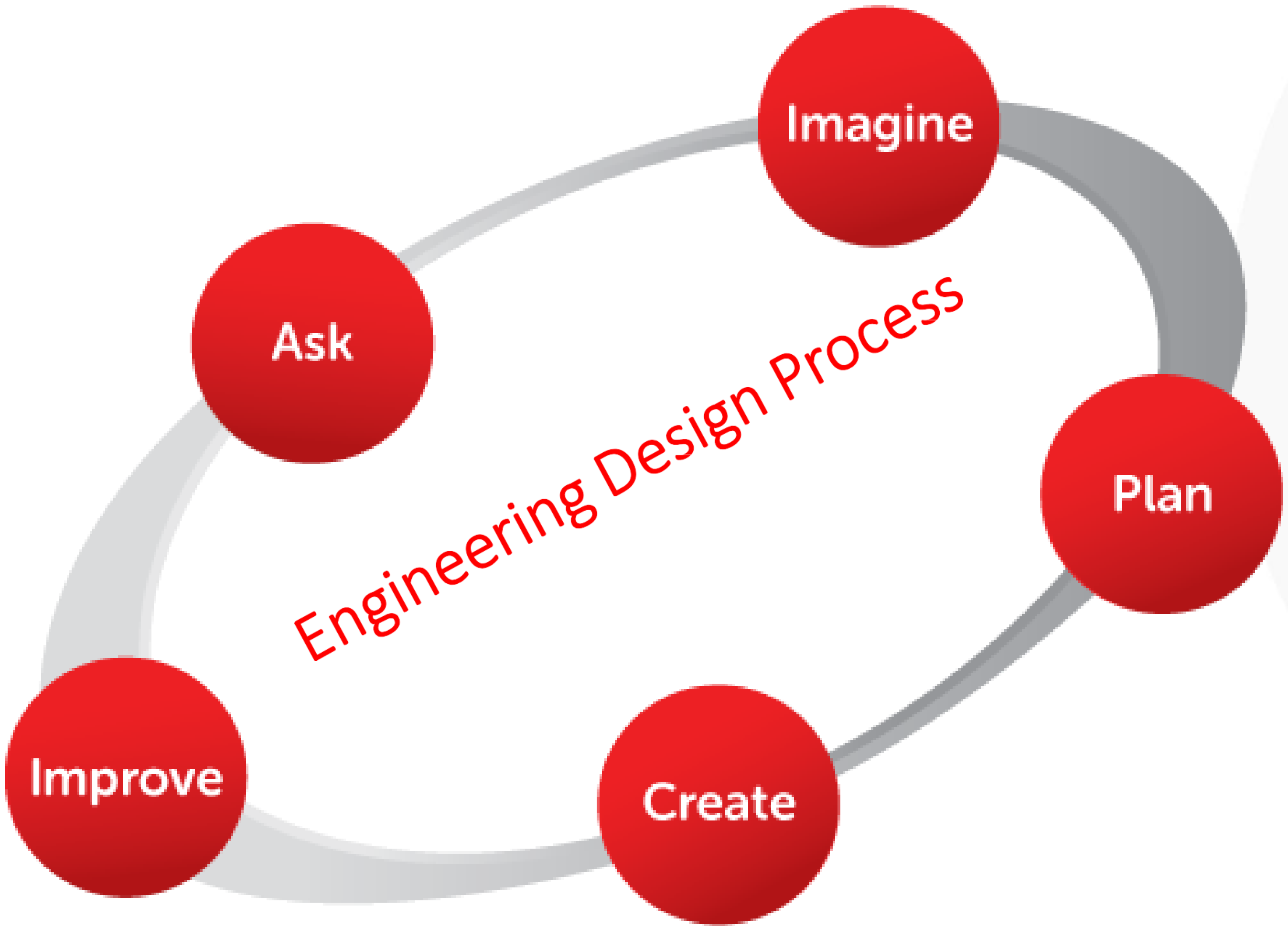
Engineering Design Process

Engineering Design Process (EDP) is a methodological step to solve problems by creating something real with a specific function. More popularly, EDP can be described as, "think like an engineer".

The creation can be in the form of a **product, process and/or system**

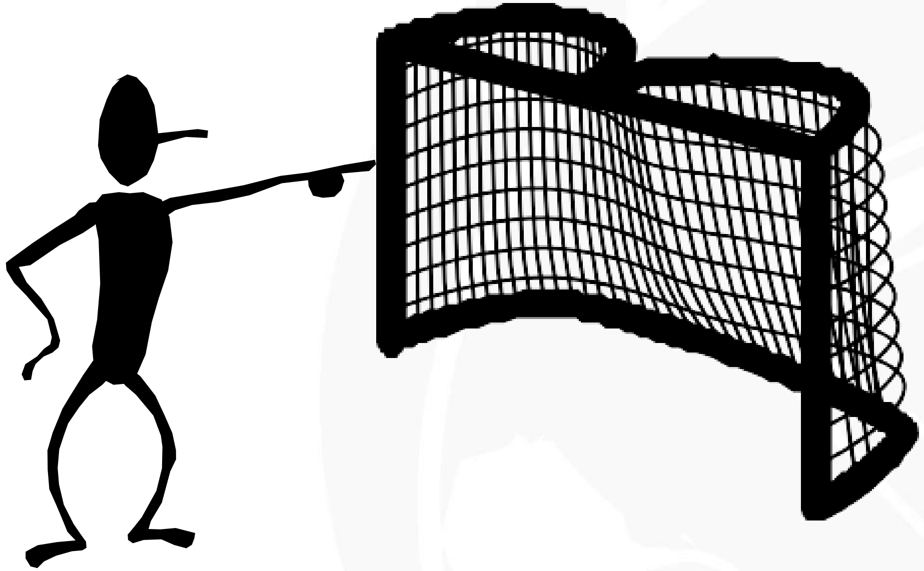
http://elearning.tki.org.nz/Teaching/Future-focused-learning/STEM-STEAM

EDP COMPONENTS IN GENERAL

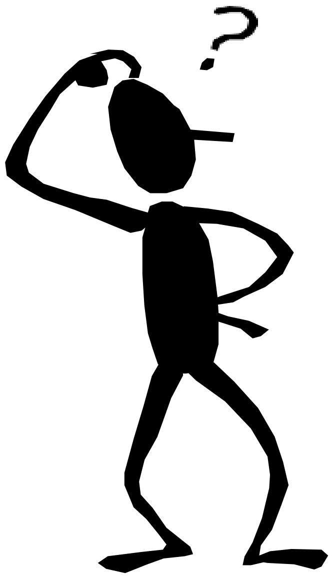


Sumber https://www.eie.org/overview/engineering-design- process

ASK



Identify and explain the main problem and objectives



by considering

- What do you want to achieve?
- What conditions are required?
- Is there a constrain?
- Who is the target?

IMAGINE

INVESTIGATE THE PROBLEM

DEVELOP VARIOUS POSSIBLE SOLUTIONS

ANALYZE IDEAS AND DETERMINE THE BEST IDEA

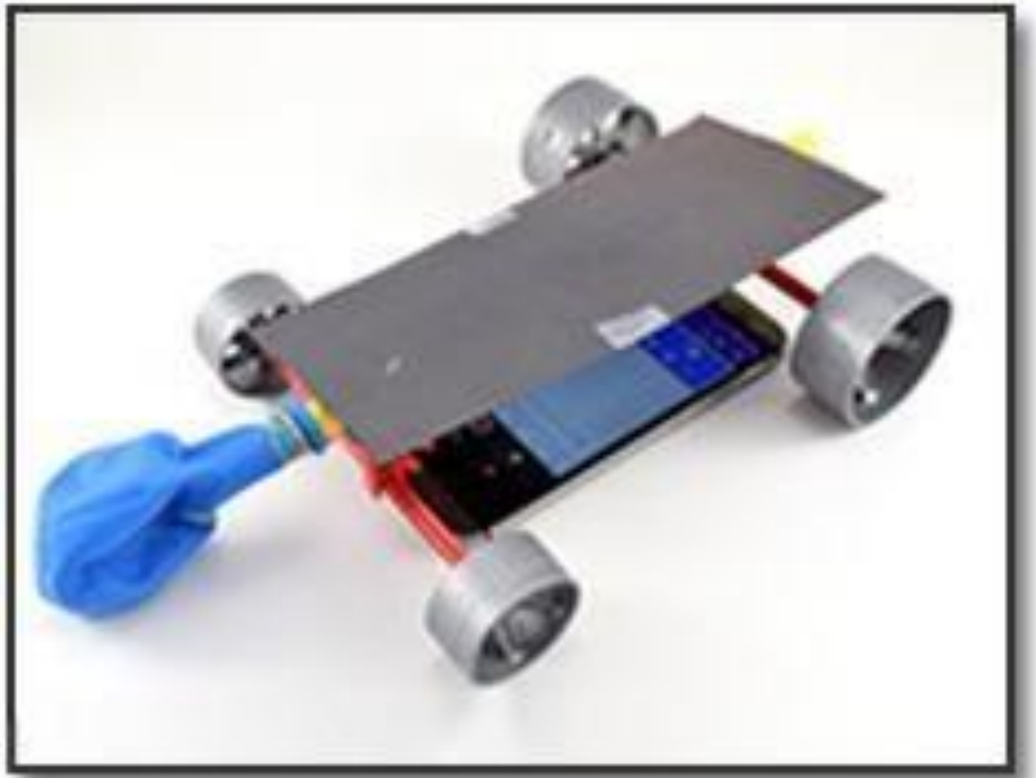
PLAN

Design the solutions (prototype design)

Determine the materials needed

CREATE

- Making prototypes
  - Prototype – an operational version of the solution. Usually made using materials that are different from the original but are cheaper and easily to find, it is necessary to test the proposed design.
- Emphasis on creativity, imagination and innovation.
- Testing the prototype



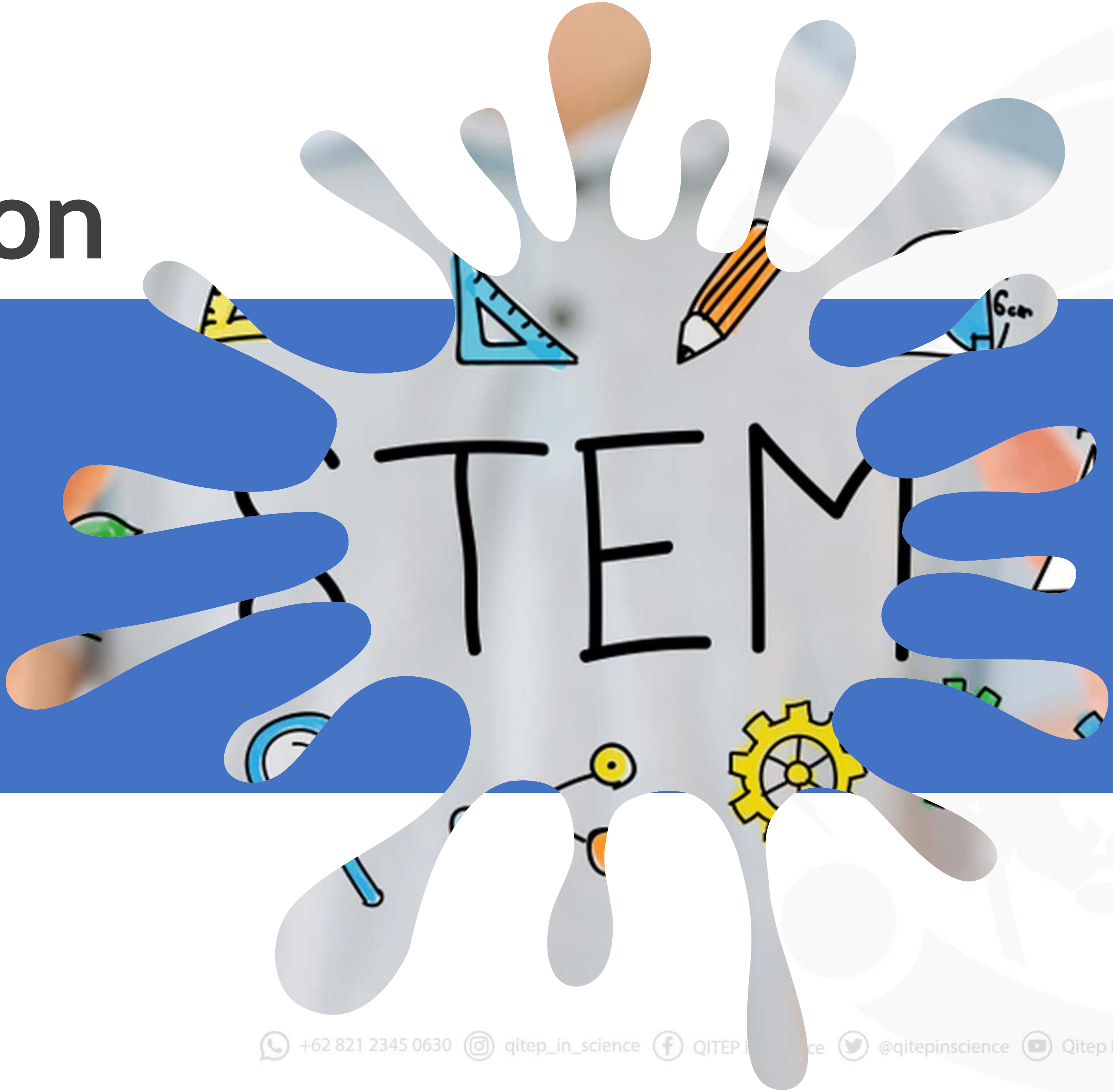
https://www.sciencebuddies.org/science-fair-projects/project-ideas/Phys_p099/physics/balloon-powered-car-challenge

IMPROVE

- Evaluating test results.
- Re-design (if needed).
- Communicating results

STEM Implementation in Science Learning

STEM Immersion Guide, A Collaboration of Arizona STEM Network Led by SFAz and Maricopa County Education Service Agency



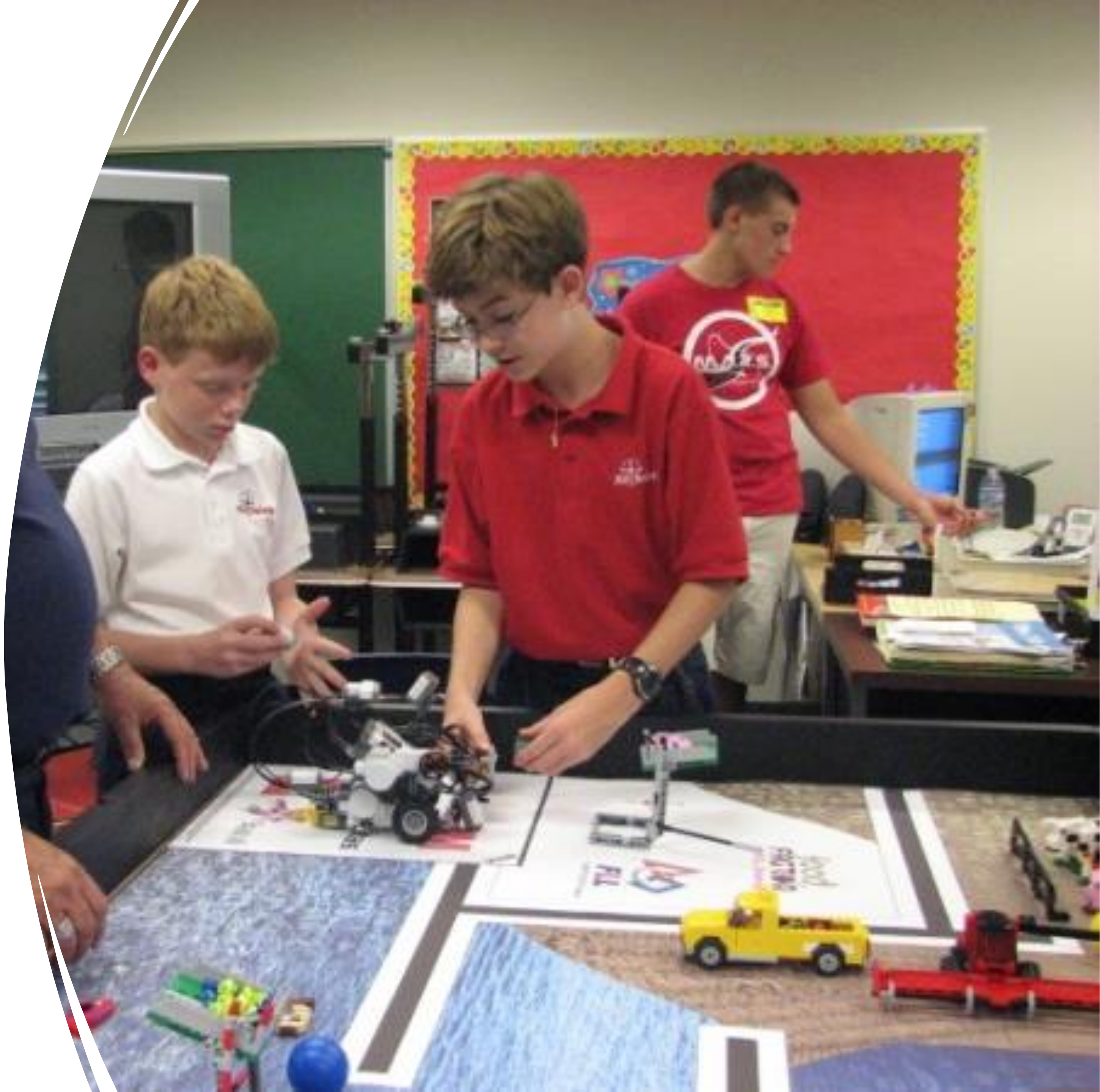
Implementation Models of STEM Learning

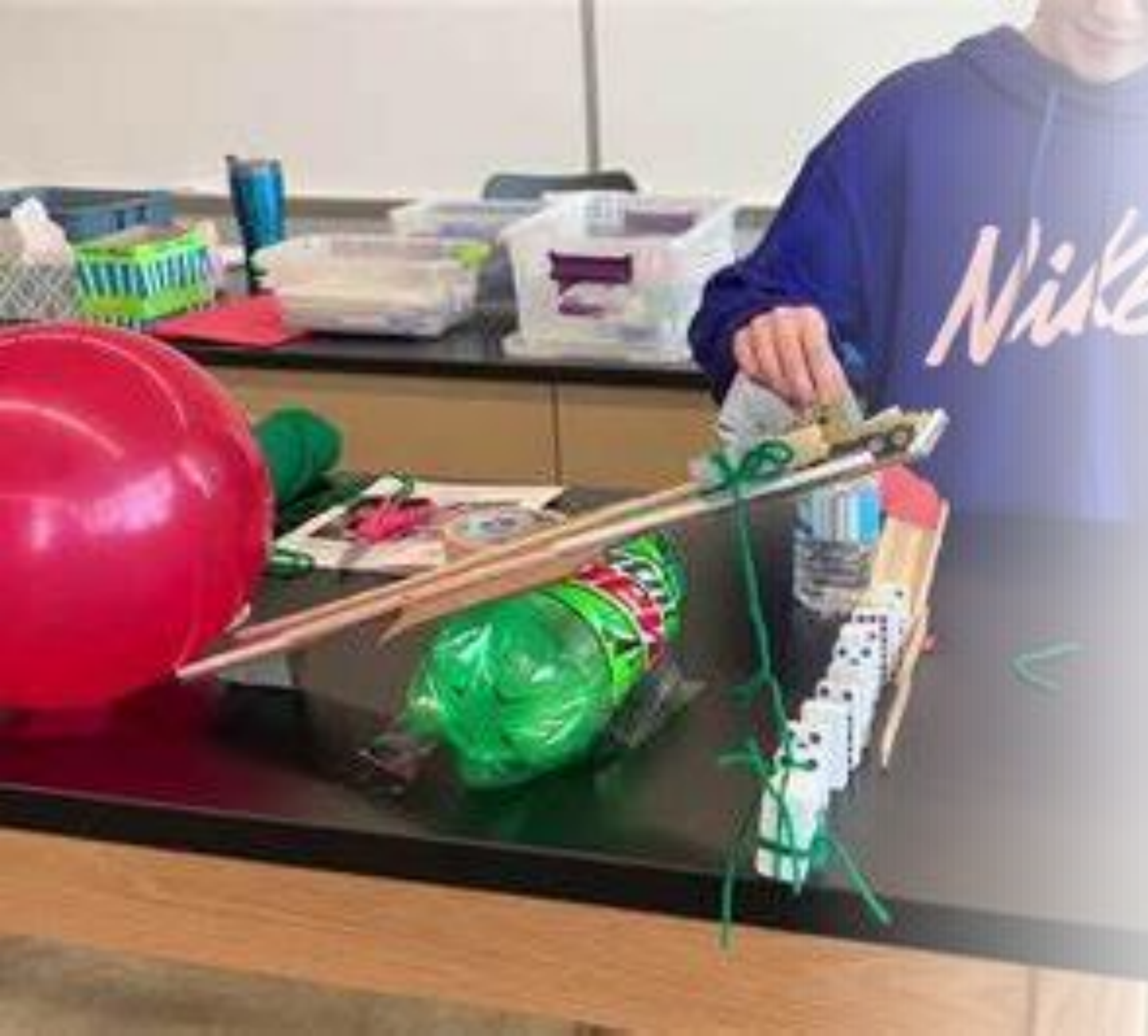
STEM Immersion Guide

Exploratory model	Extracurricular
Introductory model	School Project
Partial Immersion model	Integrated into Basic Competencies (KD)
Full Immersion model	STEM Curriculum

1. Exploratory Model

- Describes regular schools in general.
- Provide STEM experiences through **extracurricular programs** offered to students.
- Examples: Science club, robotics, youth scientific group





2. Introductory Model

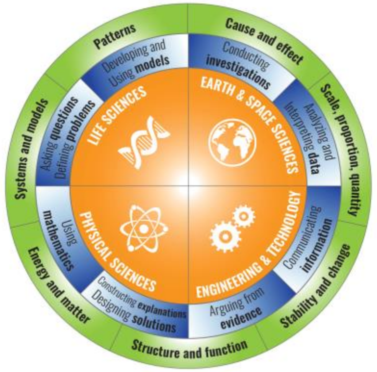
- Describes regular schools in general.
- Offering STEM programs in **addition to the existing curriculum**.
- It can be enrichment programme.
- Example: final project in the end of semester

3. Partial Immersion model

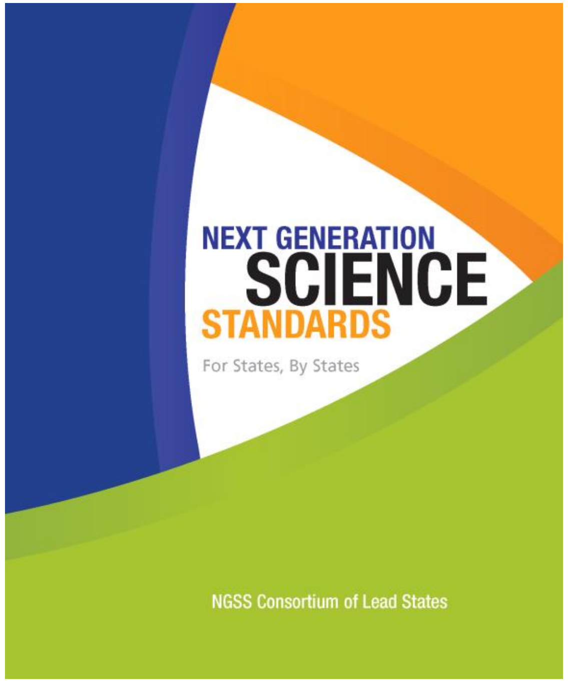
Integrate STEM into the curriculum.

- **Integrating STEM in the classroom at certain Basic Competencies.**
  - *not all physics topics in BC can be applied to STEM-based learning*
- Implementing Integrated Problem/Project Based Learning.
- Using the PJBL learning model.
- This integration model mostly use in Indonesia.

4. Full Immersion model

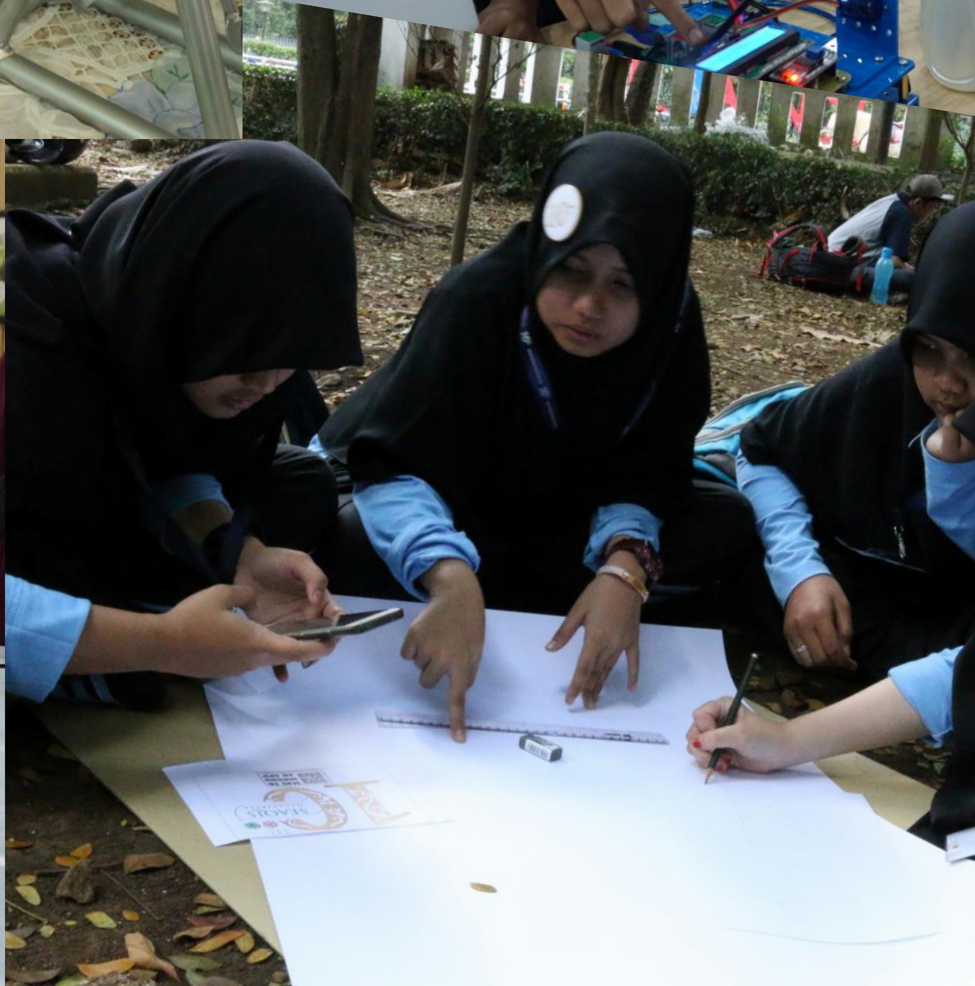


- Describes a school with a **STEM-directed curriculum**
- The school environment is similar to the 21st century work environment.
- Example: Next Generation Science Standards (USA Science Curriculum-integrated with STEM)



STEM IN FRAME


ROKET
MEDIA PEMBELAJARAN FLASH



EESD –STEM BEST PRACTICE SDN 196 SUKARASA

Achievement:
Adiwiyata Mandiri 2018

Alumni: Desy Merisa Susanti, M.Pd. / EESD 2017

TRAINING ON STEM LEARNING FOR HIGH SCHOOL PHYSICS TEACHERS IN LAMPUNG PROVINCE – COLLABORATION WITH FKIP UNILA
SEPTEMBER 2019

Thank You

Lintang Ratri Prastika
Trainer and Researcher, lintang@seameo.id, @prastikalintang

SEAMEO

SEAMEO Regional Centre for QITEP IN SCIENCE

Jl.Diponegoro 12 Bandung 40115
West Java, Indonesia

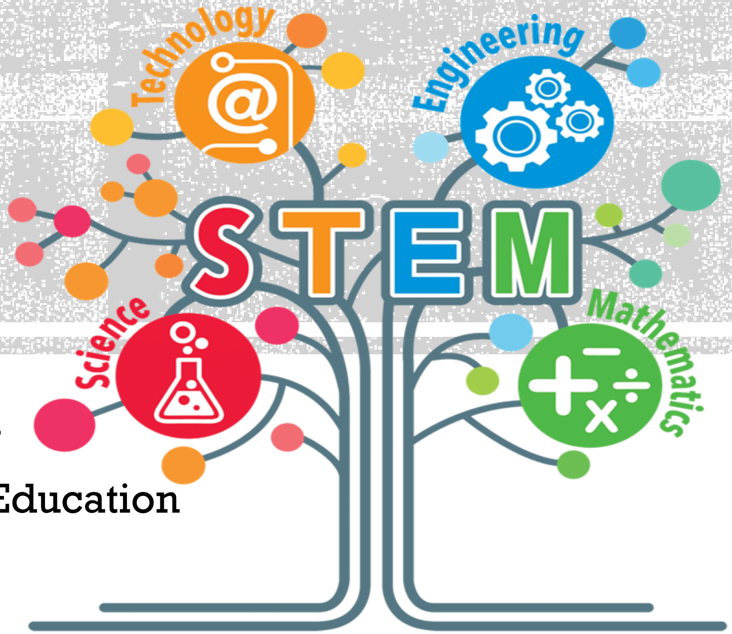
+62 22 421 8739

+62 22 421 8749

www.qitepinscience.org

secretariat@qitepinscience.org

STEM EDUCATION & MAKERSPACE: EFFORTS TO DEVELOP STUDENTS' 21st CENTURY SKILLS



Post Graduate Physics Education

Faculty of Teacher Training and Education

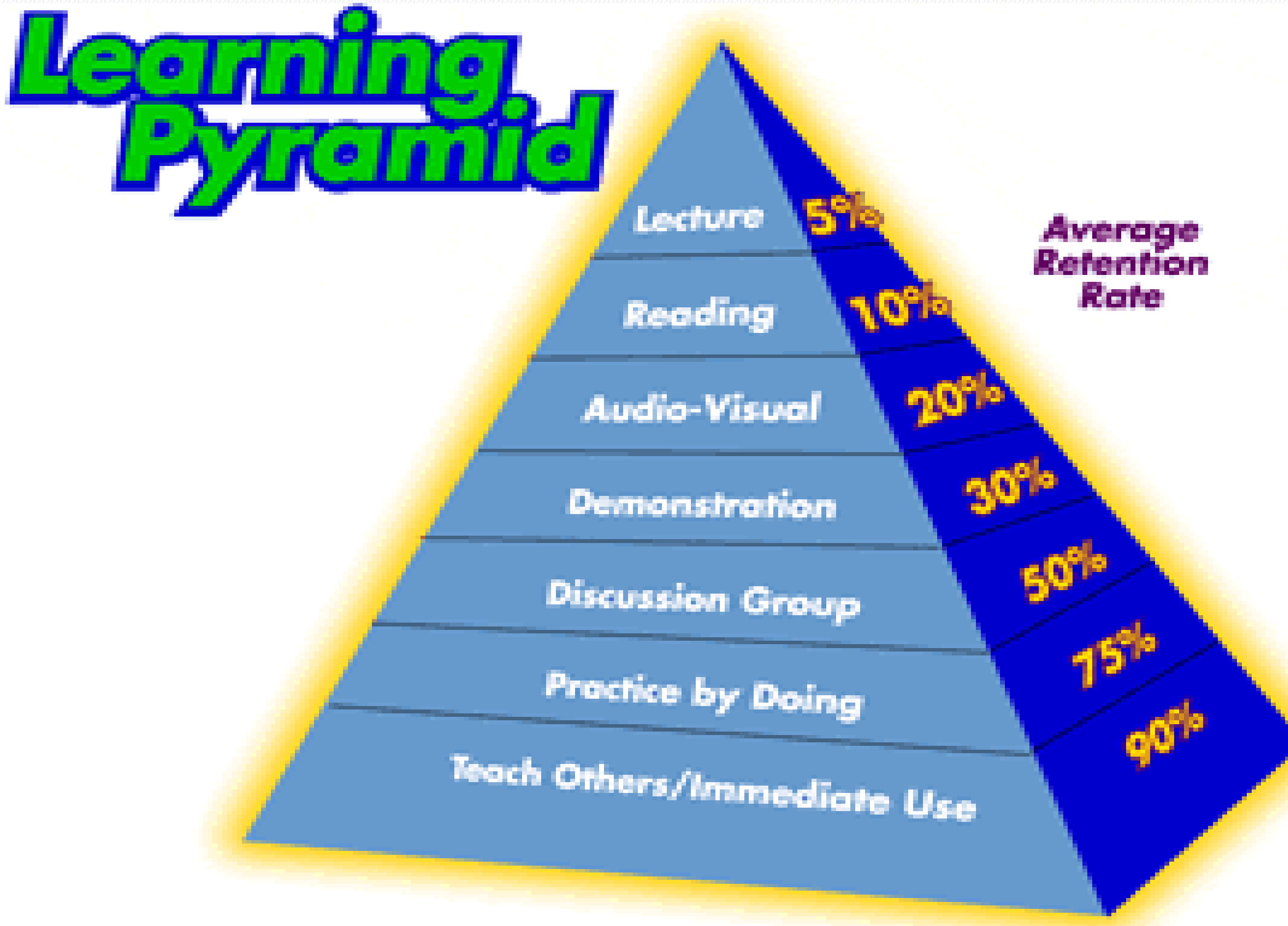
University of Lampung

Dr. Abdurrahman, M.Si.

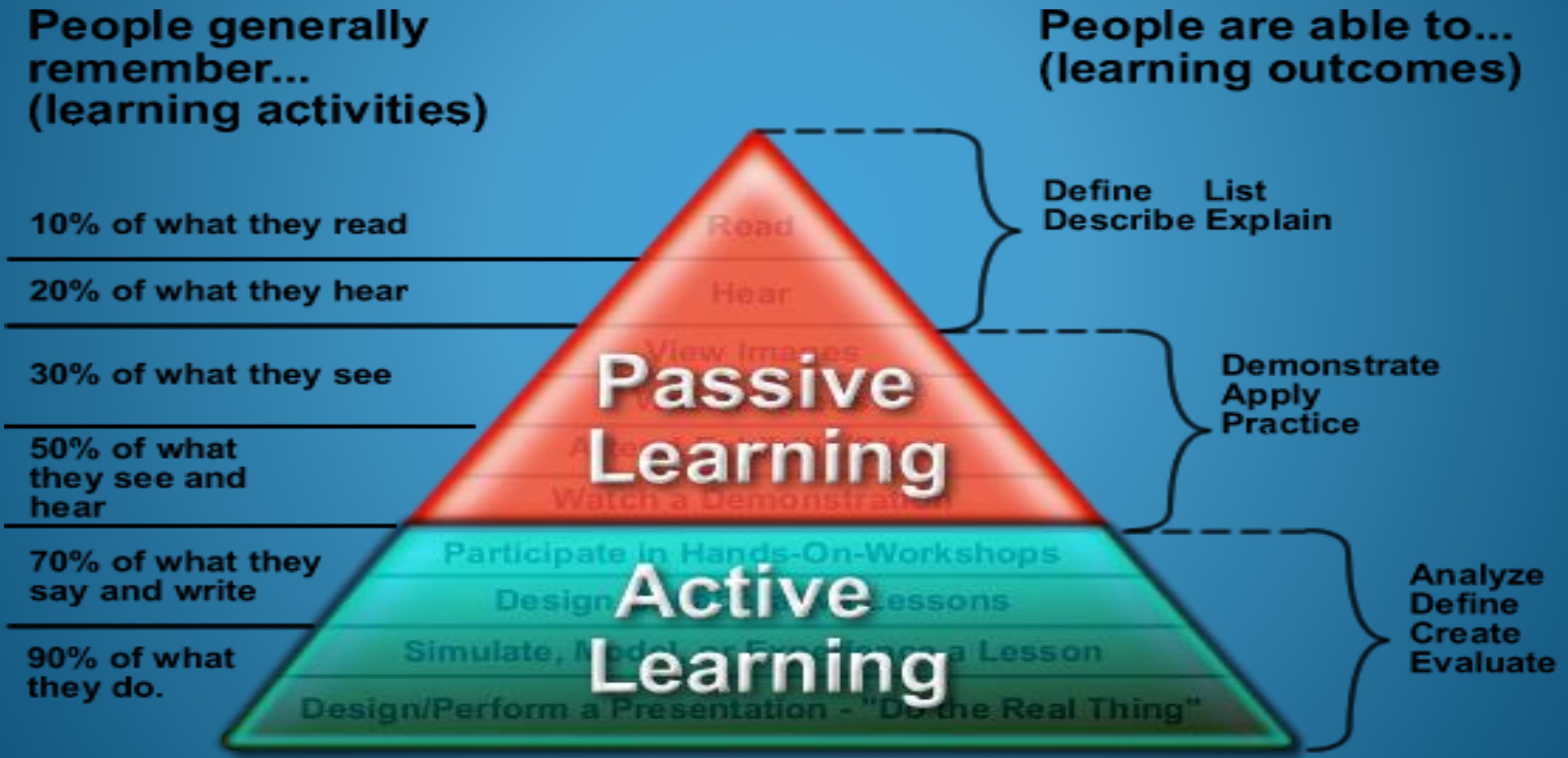
abdurrahman.1968@fkip.unila.ac.id

+628127911494

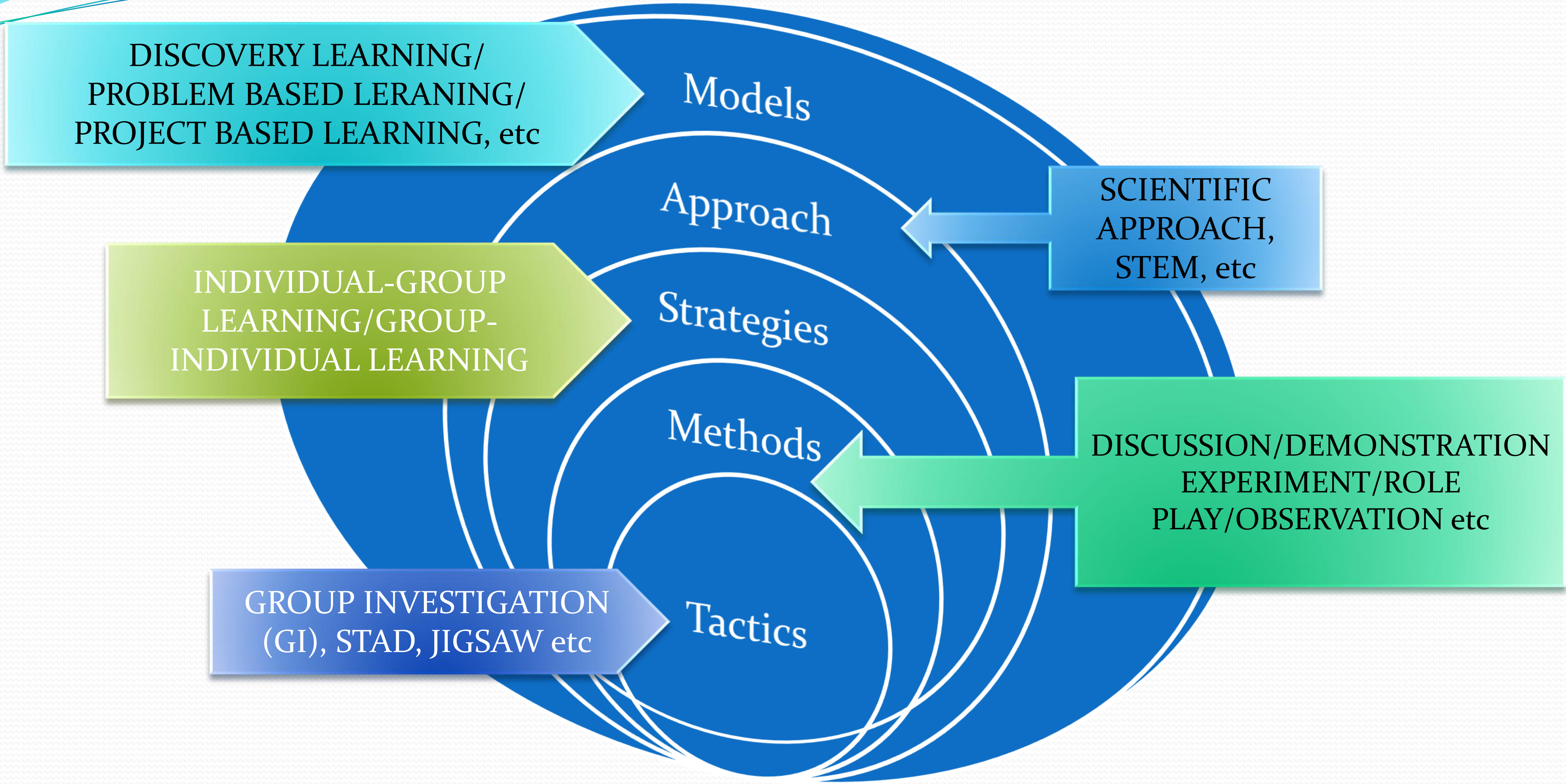
“Tell me and I forget. Show me and I remember. Involve me and I understand.” - *anonymous*



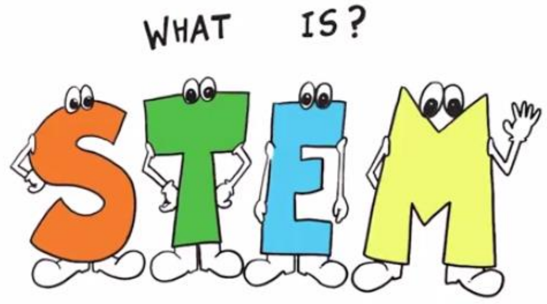
Why Active Learning?



Learning dimensions



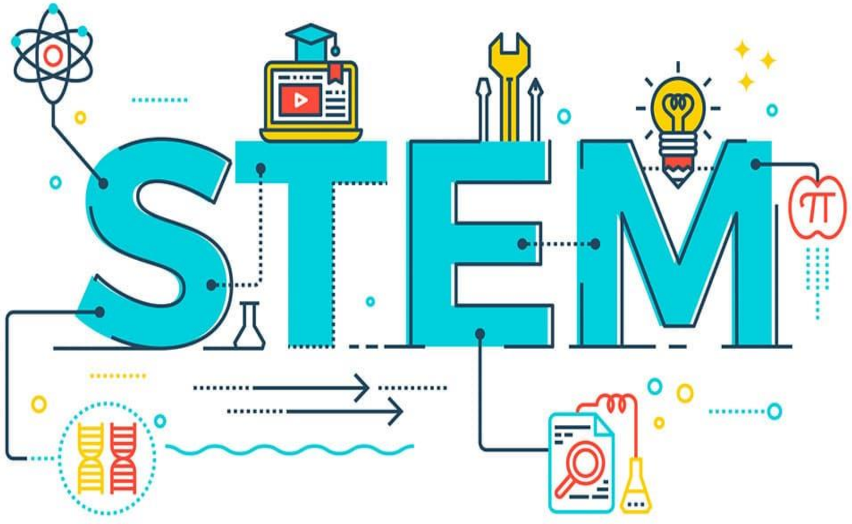
STEM = Science, Technology, Engineering, & Mathematics



- Science – Discover and describe
  - A better understanding of life (What is)
- Technology – Invent and innovate
  - Improving the natural world
- Engineering – Control, modify, or design materials, processes, and systems
  - What could be
- Mathematics –Symbolic language for representing reality
  - Making sense of the world with numbers

PREPARATION FOR LIFE

STEM prepares students to live in the future, regardless of the profession they will choose. STEM teaches students how to think critically, think creatively, and how to solve problems, which are skills that can be used throughout life.



STEM MAKERSPACE: AN ALTERNATIVE SOLUTION

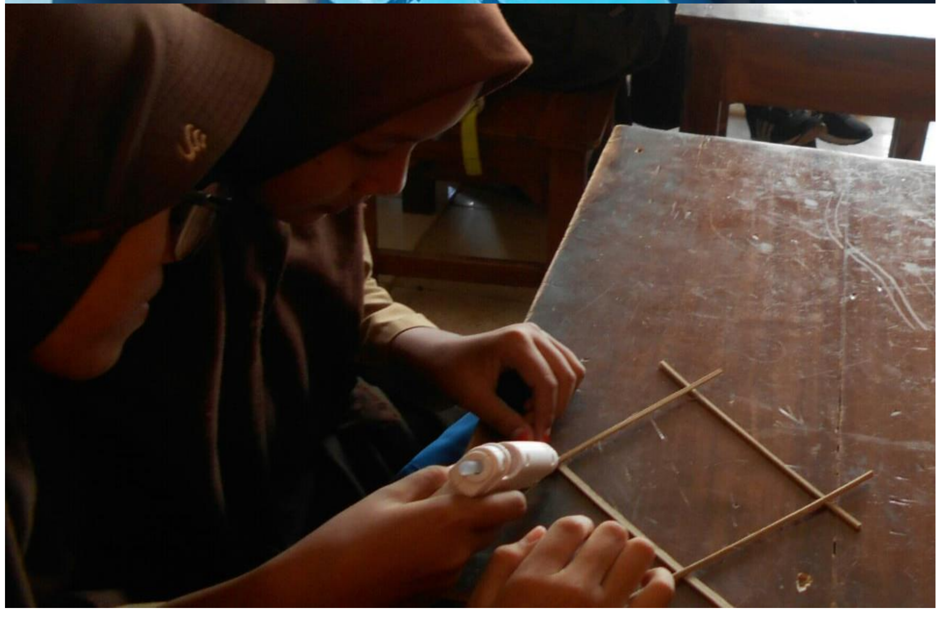
- Makerspace forms will vary, depending on the content students will learn.

- Makerspace provides opportunities for students to collaborate on hands-on learning and minds-on learning with teachers, using critical thinking skills in a creative environment.

MAKERSPACE

- **Makerspace is a space designed to support students (makers) in creating, designing, and designing projects and technologies.**

- **Makerspace is defined as a method to involve students in creative problem solving and higher order thinking through direct design, construction, and literacy (Europian Union, 2015).**



MAKERSPACE IN STEM

- The deliberate provision of space for student learning in contexts that require combining skills and knowledge from the fields of science, technology, engineering, and mathematics to create, build, and critique a product.

- Makerspaces in STEM uses creative and practical ways to inspire students to plan, research, build, and create as they participate in projects (Cooper, 2013)

STEPS TO DESIGN STEM INTEGRATED LEARNING

1

Formulating Learning objectives

2

Choose the syntax/sequence or learning model

3

Analyze STEM content and activities

Designing Learning Scenarios

4

~~Develop a lesson plan~~

Developing Learning Units

Implementation

Model 5E dengan *Engineering Design Process* (EDP)

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

STEM CONTENTS AND ACTIVITIES
TOPICS: EQUILIBRIUM OF RIGID BODY AND CENTER OF MASS

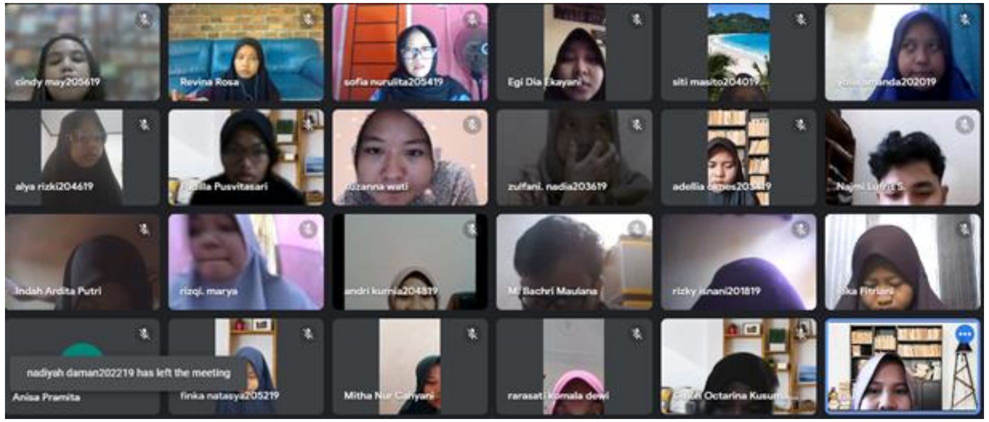
Science: **Facts: Every object has an equilibrium point and center of mass** **Concepts: equilibrium, center of mass, Center of gravity** **Procedural: The procedure for designing a tower of spaghetti-mallow that has a good balance**	**Technology:** **Using the computer (internet) to find information about the equilibrium of rigid bodies and the center of mass and its application**
Enginering: Design, build, test, revise and communicating a prototype tower made of spaghetti-mallow.	Mathematics: Determining the center of gravity of the tower prototype Estimating the center of mass of the tower prototype Determining the number of spaghetti sticks Determine the precise shape of the tower

LET'S BUILD OUR TALLEST AND MOST SOPHISTICATED TOWER!!!

DO IT YOURSELF OPTICS EXPERIMENT

Physics Laboratory at Home During the COVID-19 Pandemic

Hervin Maulina, S.Pd., M.Sc.
Department of Physics Education, University of Lampung



Hervin Maulina, S.Pd., M.Sc.
Pakuan Ratu, September 23rd 1990
hervin.maulina@fkip.unila.ac.id
Lecturer

Education:
2008-2012: Student of Departement of Physics Education, University of Lampung
2012-2014: Student of Departement of Physics, Universitas Gadjah Mada

Research interest:
Optics, Computational Physics, and Physics Education

Please visit: www.menti.com
Use the code: 27124239

https://www.mentimeter.com/s/6ade3ce4b27f341cd43d730b9b62b208/e9e70ec75f5e

BACKGROUND

The Covid-19 Pandemic has produced worldwide interruption of face to face activity not only in schools but also university

The sudden migration from face-to-face classes to online lectures caused many problems for teachers and many more arose for laboratory classes

lack of a relationship between theory and everyday life.

having to creatively adapt labs in response to the COVID-19 pandemic. The motivation behind labs can be in service of theory, in service of experiment or some combination of the two

provide hands-on, real-world experience of theoretical models. The experiences are characterized by the use of equipment that is commonly available at home or that can be purchased at a low price both in stores and online

Let's Do a simple experiment!

- Glass
- Water
- Laser/ Pencil

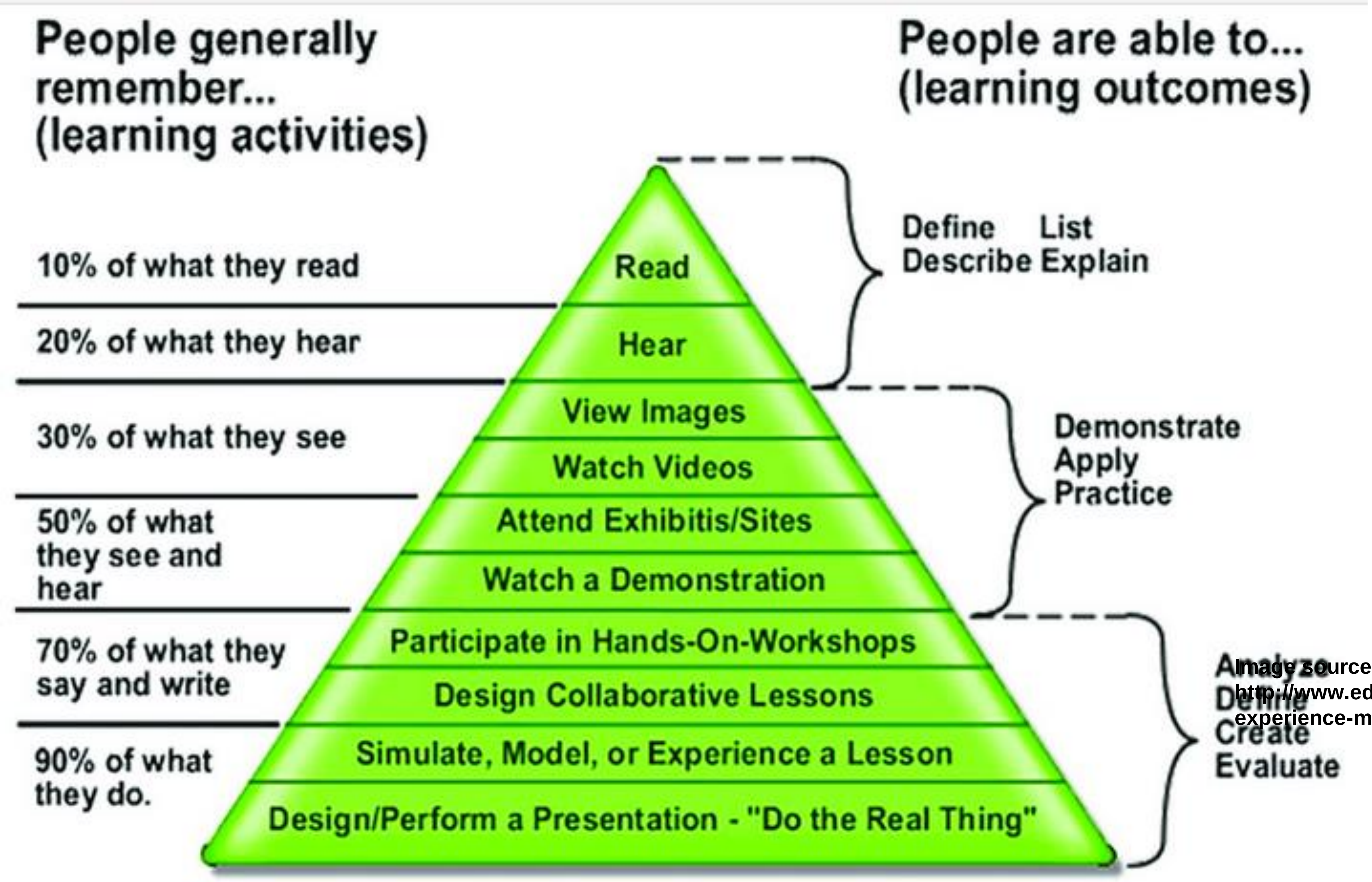


Image source: http://www.edutechie.ws/2007/10/09/cone-of-experience-media/, Author Jeffrey Anderson

DO IT YOURSELF OPTICS EXPERIMENT

WHAT?

Hands-on physics Laboratory at home

WHY?

The sudden migration from face to face classes to online lectures caused many problems for teacher and many more arose for laboratory classes

WHO?

Everyone

WHERE?

At your lovely home

HOW?

Two basic ideas guided us into formulating engaging home experiences for the students

We describe how we overcame this problem
by enabling the students to perform various physics experiments at home.

How to begin Physics Laboratory at home?

Compentences Analysis

1. Analyze and determine the competencies to be achieved
2. Select and specify the topics

Learner's characters

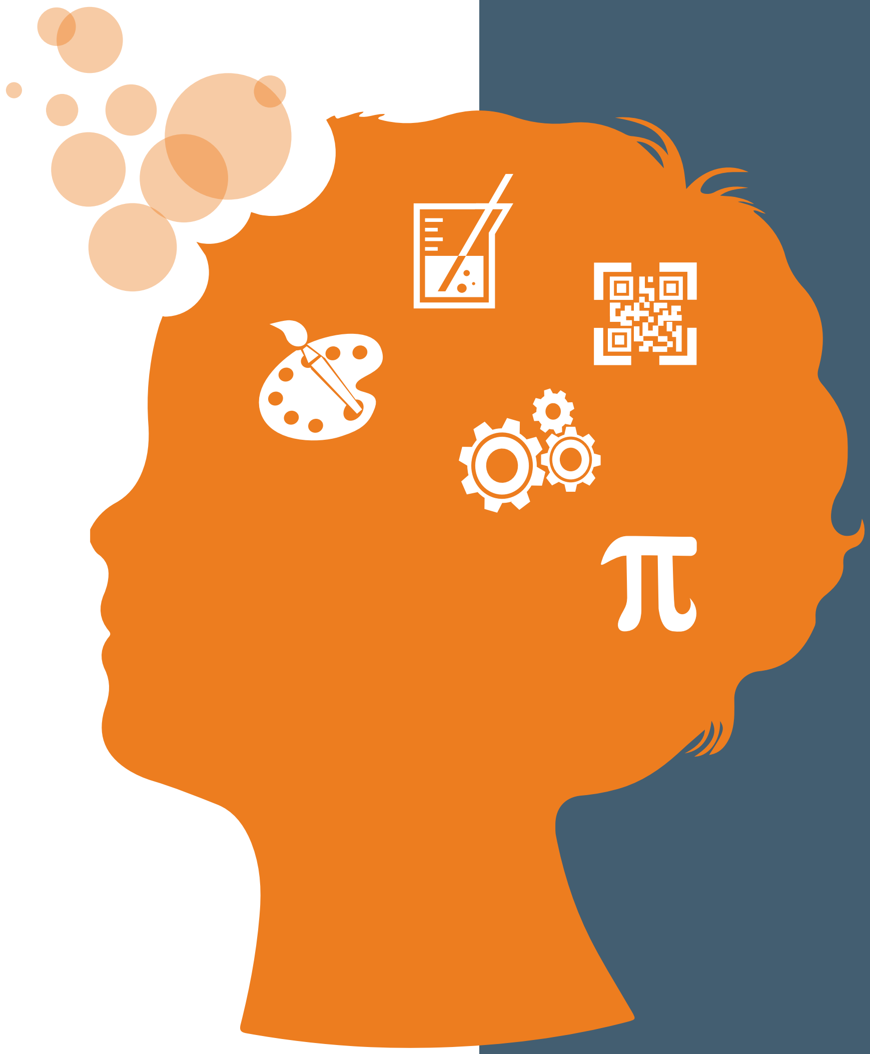
1. Active/passive
2. Socio culture background, etc

Experimental Design

Equipment/tools that are commonly available at home or that can be purchased at a low price both in stores and online

LET'S TRY THE EXAMPLES

1. Snell's law
2. Difraction gratings
3. Total internal Reflection



SOME IDEAS

OPTICS LABORATORY AT HOME

1. REFLECTION
2. REFRACTION
3. TOTAL INTERNAL REFLECTION
4. DIFFRACTION

REFLECTION

REFRACTION

SIMPLE PROYEKTOR

https://www.youtube.com/watch?v=Qa5g6gGJ_oM&t=5s

TOTAL INTERNAL REFLECTION

https://drive.google.com/file/d/1RUheJZij8H_hEQR-oDlgKDkohAuW6H4f/view?usp=sharing

DIFFRACTION

Setup of the optical experiment, from a picture taken by one of the students. The light emitted by the pointer strikes a CD and is diffracted, producing a central spot on the wall together with two clearly visible interference maxima.

THANK YOU!

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI
UNIVERSITAS LAMPUNG
LEMBAGA PENELITIAN DAN PENGABDIAN KEPADA MASYARAKAT
Gedung Rektorat Lantai 5, Jalan Prof. Dr. Sumantri Brojonegoro No. 1 Bandar Lampung 35145
Telepon (0721) 705173, Fax. (0721) 773798, e-mail : lppm@kpa.unila.ac.id
www.lppm.unila.ac.id

SURAT TUGAS
Nomor : 5434/UN26.21/PM/2021

Berdasarkan Surat Dekan Fakultas Keguruan dan Ilmu Pendidikan Universitas Lampung Nomor: 6831/UN26.13/PM/2021, tanggal 13 Oktober 2021 dengan ini Ketua Lembaga Penelitian dan Pengabdian kepada Masyarakat Universitas Lampung, menugaskan kepada :

NO	NAMA	NIP/NIK/NPM	JABATAN
1.	Prof. Dr. Agus Suyatna, M.Si	196008211985031004	Dosen FKIP Unila
2.	Dr. Abdurrahman, M.Si	196812101993031002	Dosen FKIP Unila
3.	Dr. I Wayan Distrik, M.Si	196312151991021001	Dosen FKIP Unila
4.	Hervin Maulina, S.Pd., M.Sc	2316019900923201	Dosen FKIP Unila
5.	Novinta Nurulsari, S.Pd., M.Pd	231804931117201	Dosen FKIP Unila
6.	Alyana Atina	1813022012	Mahasiswa
7.	Ajeng Rahayu	1813022004	Mahasiswa

untuk melaksanakan kegiatan Pengabdian kepada Masyarakat dengan judul **"*International Workshop on* STEM *Education: Integrating Science, technology, Society, and Environment for Fostering Inservice Teacher* TPACK"**, yang akan dilaksanakan pada :

Hari/Tanggal : Kamis, 14 Oktober 2021
Tempat : FKIP Universitas Lampung

Demikian surat tugas ini dibuat untuk dapat dipergunakan sebagaimana mestinya.

Bandar Lampung, 13 Oktober 2021
Ketua,

Dr. Ir. Lusmeilia Afriani, D.E.A
NIP 196505101993032008

Tembusan :
Dekan FKIP Unila

Timestamp	Full Name	Institution	Country	Phone Number (WhatsAp	Active Email	
10/14/2021 9:21:16	Rita Aprilyawati	SMAN 2 Bandar Lampung	Indonesia	085768935922	ritasawit@gmail.com	
10/14/2021 10:04:52	Karlina Maya Mulyana	SMA IT FITRAH INSANI	Indonesia	082311524171	karlinamaya65@gmail.com	
10/14/2021 10:39:13	Dr. Muhammad Syukri, S.	Universitas Syiah Kuala	Indonesia	085296103331	syukri.physics@unsyiah.ac.id	
10/14/2021 10:39:32	Muhammad Erfan	Universitas Mataram	Indonesia	+6282325653225	erfun1234@gmail.com	
10/14/2021 10:39:39	Haditya Aprita Lora	SMP IT DAARUL ILMI BA	Indonesia	082190795308	h.apritalora@gmail.com	
10/14/2021 10:39:55	Luh Sukariasih, S.Pd.,M.P	UHO	Indonesia	085218232800	luhsukariasih76@gmail.com	
10/14/2021 10:40:02	MUZAKIAH	Universitas Syiah Kuala	Indonesia	082285659118	muzakiah56@gmail.com	
10/14/2021 10:40:06	Dr. Asri Widowati	UNY	Indonesia	081804758907	asri_widowati@uny.ac.id	
10/14/2021 10:40:25	Handono Suwarno,S.Si	SMKN 1 Seputih Agung	Indonesia	082176914982	handono46p@gmail.com	
10/14/2021 10:40:59	HENDRI PRASETIO	-	Indonesia	+6285758441896	phendri.7@gmail.com	
10/14/2021 10:41:21	Mohamad Fahmi Hafidz	SMK Tri Sukses Lampung	Indonesia	089691561660	fahmidzic2015@gmail.com	
10/14/2021 10:41:55	Asri Fauzi, S. Pd., M. Pd.	Universitas Mataram	Indonesia	081997733966	asrifauzi@unram.ac.id	
10/14/2021 10:42:02	Varida Hariani,S.Pd	SDN 105335 KEBUN SAY	Indonesia	082285011410	harianivarida@gmail.com	
10/14/2021 10:42:15	Drs. I Wayan Merta, M. Si	FKIP Universitas Mataram	Indonesia	085954555414	wayanmerta.fkip@unram.ac.id	
10/14/2021 10:42:22	Chandra Ertikanto	Universitas Lampung	Indonesia	085279695511	chandrafkipunila@gmail.com	
10/14/2021 10:42:24	Dr. Amiruddin Takda, S.Pd	FKIP Universitas Halu Ole	Indonesia	081341510766	amiruddintakda70@gmal.com	
10/14/2021 10:42:54	RATIH DWI YUNIARTI	SMP N 1 PALAS	Indonesia	085800274258	ratihlidya77@gmail.com	
10/14/2021 10:43:21	Dr. Syahmani, M. Si.	ULM Banjarmasin	Indonesia	085821029982	syahmani_kimia@ulm.ac.id	
10/14/2021 10:44:48	Annevia Juris	University Putra Malaysia	Malaysia	010-2834155	anneviajuris@gmail.com	
10/14/2021 10:45:06	Muthmainnah	SMP Negeri Satap 3 Baya	Indonesia	08175700723	iinmuth.muthmainnah@gmail.com	
10/14/2021 10:45:52	NUR SETYOWATI, S.Pd	SDN 1 NGROGUNG, KE(	Indonesia	082336890433	nursetyowati86@gmal.com	
10/14/2021 10:45:56	Elysana Mulyadi	SDN CIBALONGSARI IV	Indonesia	0895340593775	elysana37@gmail.com	
10/14/2021 10:46:34	Sihatul Fitriyah	SDN Kubangsari 02	Indonesia	089661147623	sihatulfitriyah21@gmail.com	
10/14/2021 10:46:38	Cokorda Istri Agung Wijay	SD Negeri 3 Ubud	Indonesia	081239588828	coksi1491@gmail.com	
10/14/2021 10:46:47	Sri Rahmatika, S.Pd.SD	SDN 30 Nitu Kota Bima	Indonesia	085253902409	Srirahmatika.sdn30kobi@gmail.com	
10/14/2021 10:47:33	Ni Putu Ayu Supartini,S.P	SDN. 2 Baler Bale Agung	Indonesia	081805344496	ayusupartini1986@gmail.com	
10/14/2021 10:47:55	Sestika Sari, M.Pd	Sekolah Qur'an Darul Fat	Indonesia	085266335620	sestikasari24@gmail.com	
10/14/2021 10:48:50	AA Sukarso	Universitas Mataram	Indonesia	08175796370	asukarso@unram.ac.id	
10/14/2021 10:48:52	Aisa Nikmah Rahmatih	Universitas Mataram	Indonesia	089667787883	aisanikmahrahma07@unram.ac.id	
10/14/2021 10:50:05	NUR AFIQAH BINTI MOH	UNIVERSITI PUTRA MAL	Malaysia	0138242398	afiqahindera@gmail.com	
10/14/2021 10:50:22	NURFARZANA ATIKAH B	UNIVERSITI PUTRA MAL	Malaysia	01124083476	farzanazaini99@gmail.com	
10/14/2021 10:50:41	Dian Ekasari	SMP IT Permata	Indonesia	085669675763	tehdianeka@gmail.com	

Timestamp	Full Name	Institution	Country	Phone Number (WhatsAp	Active Email	
10/14/2021 10:51:57	Muh. Arsad, S.Pd	SMK Negeri 2 Bungku Ba	Indonesia	082259772279	spdarsad@yahoo.co.id	
10/14/2021 10:55:43	Munib, S.T., M.Pd.	STIS Darul Falah Pagutar	Indonesia	087709206688	munib7572@gmail.com	
10/14/2021 10:57:14	Irwandi, Ph.D	Universitas Syiah Kuala	Indonesia	085260104417	irwandi@unsyiah.ac.id	
10/14/2021 10:57:33	Amrullah	Universitas Mataram	Indonesia	081803644775	amrullah@unram.ac.id	
10/14/2021 10:58:55	Vita Ria Mustikasari	Universitas Negeri Malang	Indonesia	085231844564	vita.ria.fmipa@um.ac.id	
10/14/2021 10:59:30	Intan Mulia Sari	Pusat Riset STEM Univer	Indonesia	085358672213	intan.shirazy@gmail.com	
10/14/2021 11:02:53	Rahmad Fajar Sidik, S.Si.	Universitas Trunojoyo Ma	Indonesia	085692033898	rahmadfajarsidik@gmail.com	
10/14/2021 11:08:36	Mida Ayu Restanti	SMPN 2 MENGGALA TIM	Indonesia	082282928554	midaayurestati@gmail.com	
10/14/2021 11:09:30	Hendrawani, M.Pd.	Undikma	Indonesia	081918233355	hendrawanichemed@gmail.com	
10/14/2021 11:09:50	Agus Setiawan	SMA Muhammadiyah 2 B	Indonesia	085269106568	setiawanagu@gmail.com	
10/14/2021 11:09:58	M. Yustiqvar, M.Pd	Universitas Mataram	Indonesia	082341839266	myustiqvar2018@gmail.com	
10/14/2021 11:10:36	SUSI HARNANI	SMA NEGERI 3 METRO	Indonesia	081369419623	susiharnani@gmail.com	
10/14/2021 11:11:55	Tursina Ratu	Universitas Samawa	Indonesia	+6285325689200	ratutursina@gmail.com	
10/14/2021 11:12:57	Iva Nurmawanti	university of mataram	Indonesia	081235536929	ivanurmawanti@unram.ac.id	
10/14/2021 11:17:54	Dra.Erniwati, M.Si	Universitas Halu Oleo	Indonesia	081341540502	erniwati@uho.ac.id	
10/14/2021 11:19:48	FITRA MERASARI, S.Pd.	SMP Global Madani	Indonesia	085269404942	fitriamerasari208@gmail.com	
10/14/2021 11:30:11	Souliyanh PHIMMASONE	Savannakhet Teacher Tra	Lao PDR	+85620 77477227	Souliyanhp@yahoo.com	
10/14/2021 11:31:29	Reni Dwi Puspitasari, M.F	IAI ANNur Lampung	Indonesia	085895056491	renidps53@gmail.com	
10/14/2021 11:31:34	Agus Ramdani	Universitas Mataram	Indonesia	0818367605	aramdani07@unram.ac.id	
10/14/2021 11:31:55	LA ODE SUAYIB, S.Pd	SMA KARTIKA XX-2 KEN	Indonesia	081245695008	suaib873@gmail.com	
10/14/2021 11:35:19	Septa Niti Susanti, S.Pd.	SMPN SATAP 3 SIDOMU	Indonesia	082176799722	nitisusantisepta@gmail.com	
10/14/2021 11:40:44	Andika Prasetya, S.Pd	UPT SMPN 2 Pardasuka	Indonesia	082280688284	andikamencarisangguru79@gmail.com	
10/14/2021 11:42:17	Ratna Yulia	LPMP Provinsi Aceh	Indonesia	081377106557	yuliaratna006@gmail.com	
10/14/2021 11:43:09	Sari Retno Wulandari	SMA Negeri 2 Simpang P	Indonesia	082289491152	sariretno2626@gmail.com	
10/14/2021 11:46:52	Erni Yulianti	Universitas Negeri Malang	Indonesia	085646502073	erni.yulianti.fmipa@um.ac.id	
10/14/2021 11:47:06	Tiurma PT Simanjuntak S	Raffles Christians Internat	Indonesia	081370213203	tielumphd@gmail.com	
10/14/2021 12:00:26	Zunuyawati, M. Pd	SMA Muhammafiyah 2 B.	Indonesia	082182075248	Zuniawati.ss@gmail.com	
10/14/2021 12:01:58	Sa'idah	University of Mataram	Indonesia	087761489176	saidahidah1999@gmail.com	
10/14/2021 12:37:23	Sunaryo Romli	SMP IT Ar Raihan Bandar	Indonesia	085384499994	sunaryoromli@gmail.com	
10/14/2021 14:55:07	Dr. Abdul Gani, M.Si.	Universitas Syiah Kuala	Indonesia	08121815214	aganihaji@unsyiah.ac.id	
10/14/2021 14:56:03	Nasrun Reli	SMAS Satria Kendari	Indonesia	085242511549	nasrunamu@gmail.com	

Timestamp	Full Name	Institution	Country	Phone Number (WhatsAp	Active Email	
10/14/2021 15:54:22	Irwandi	Universitas Syiah Kuala	Indonesia	085260656995	irwandi@unsyiah.ac.id	