

Beginning Physics Experiments Class Using Multi Media in National University of Laos

T. Nagata, S. Xaphakdy, P. Souvannavong, P. Chanthamaly, K. Sithavong, C. H. Lee, S. Phommathat, V. Srithilat, P. Sengdala, B. Phetarnousone, B. Siharath, X. Chemcheng, T. Yamaguchi, A. Suenaga, S. Kashima

Abstract—National University of Laos (NUOL) requested Japan International Cooperation Agency (JICA) volunteers to begin a physics experiments class using multi media. However, there are issues. NUOL had no physics experiment class, no space for physics experiments, experiment materials were not used for many years and were scattered in various places, and there is no projector and laptop computer in the unit. This raised the question: How do authors begin the physics experiments class using multimedia? To solve this problem, the JICA took some steps, took stock of what was available and reviewed the syllabus. The JICA then revised the experiment materials to assess what was available and then developed textbooks for experiments using them; however, the question remained, what about the multimedia component of the course? Next, the JICA reviewed Physics teacher Pavy Souvannavong’s YouTube channel, where he and his students upload video reports of their physics classes at NUOL using their smartphones. While they use multi-media, almost all the videos recorded were of class presentations. To improve the multimedia style, authors edited the videos in the style of another YouTube channel, “Science for Lao,” which is a science education group made up of Japan Overseas Cooperation Volunteers (JOCV) in Laos. They created the channel to enhance science education in Laos, and hold regular monthly meetings in the capital, Vientiane, and at teacher training colleges in the country. They edit the video clips in three parts, which are the materials and procedures part including pictures, practice footage of the experiment part, and then the result and conclusion part. Then students perform experiments and prepare for presentation by following the videos. The revised experiment presentation reports use PowerPoint presentations, material pictures and experiment video clips. As for providing textbooks and submitting reports, the students use the e-Learning system of “Moodle” of the Information Technology Center in Dongdok campus of NUOL. The Korean International Cooperation Agency (KOICA) donated those facilities. The authors have passed the process of the revised materials, developed textbooks, the PowerPoint slides presented by students, downloaded textbooks and uploaded reports, to begin the physics experiments class using multimedia. This is the practice research report for beginning a physics experiments class using multimedia in

T. Nagata was with Hokkaido Science Education Center in Japan, University of Malaya in Malaysia, and Hokkaido University in Japan. He is now with Japan International Cooperation Agency in Laos, P.O. Box 3932 Vientiane Laos, (phone: +856-20-5970-7337; fax: +856-21-241101; e-mail: 0k0t.nagata@gmail.com).

S. Xaphakdy is with Department of Natural Science, Faculty of Education, National University of Laos, P.O. box 7322, Vientiane Laos, (phone: +856-20-54804165; e-mail: xaphakdy.s@nuol.edu.la).

P. Souvannavong is with the Department of Natural Science, Faculty of Education, National University of Laos.

P. Chanthamaly and Khamphanh Sithavong are with Information Technology Center, National University of Laos, C. H. Lee is with the Korea International Cooperation Agency in Laos.

S. Phommathat, V. Srithilat, P. Sengdala, B. Phetarnousone, B. Siharath, and X. Chemcheng are with National University of Laos. Tetsuhiro Yamaguchi, Akemi Suenaga, Suguru Kashima are with JICA Laos.

the physics unit at the Department of Natural Science, Faculty of Education, at the NUOL.

Keywords—NUOL, JICA, KOICA, Physics experiment materials, smart phone, Moodle, IT center, Science for Lao.

I. INTRODUCTION

LAOS is a social republic country that was declared independent from France in 1949. The country was ravaged by Indochina war until the proclamation of Lao P.D.R. on the 2nd December 1975. Laos is a land-locked country that sits inside of the Indochina Peninsula. The country covers an area of 236,800 km² and has a population of about 6,800,000 people (in 2015), and has two seasons: wet and dry. It is one of the least developed countries in South East Asia. The country’s main development budget is supported by foreign countries - China, Japan, Vietnam, etc. Laos has a plentiful supply of water that enables it to generate and export vast amounts of hydroelectricity. As a developing country, it lacks sufficient infrastructure even though progress is being made through government supported plans and public-private partnerships. Laos is now also building the foundations for education and teacher training [19].



Fig. 1 Map of NUOL

Understanding the condition of education in the country is the first step. The NUOL was established 20 years ago. At present, the number of academic staff is 1,155. The university has two campuses – Dongdok campus, and the Engineering campus located in Sokphaluang. The Dongdok campus consists of nine faculties, two institutes and three centers, as shown in Fig. 1. The Faculty of Education consists of seven departments – Natural Sciences, Social Sciences, Psychology, Lao Language, Foreign Languages, and Administration Management and Physical Education. In 2015, the faculty has 280 staff and 3,408 students. Among the academic staff, 13 are associate professors, 11 have obtained doctoral degrees, 75 have obtained master's degree and 178 have obtained bachelor's degree. They also have demonstration high school (1,900 students), Primary school (560 students), and kindergarten (370 students).

The Natural Sciences department consists of four units – Mathematics, Physics, Chemistry and Biology. There are 968 students; 235 mathematics students, 220 physics students, 219 biology students, 221 chemistry students and 62 mathematics continuity students. The department has 28 teaching staffs (seven staff for Mathematics, six staff for Physics, four staff for Chemistry, three staff for Biology, and two staff for Computer and six staff for others). The faculty accepted two JICA volunteers to work in the field of biology experiments during 2009 – 2010 and during 2011 – 2013 academic years. The faculty offers a high school science teacher-training course, as well as a two-year Mathematics continuity course that enables student with diploma to pursue a bachelor degree.

The Physics unit currently has 58 first-year students, 27 second-year students, 64 third-year students, and 64 fourth-year students.

A. Syllabus of High School Physics Teacher Training Course

The curriculum of the physics unit consists of four subject groups for a total of 160 credits. The general knowledge subjects group is worth 20 credits, the Fundamental subject group has 95 credits, the Specific subject group has 41 credits, and the Select subject group has four credits.

The general knowledge subject group consists of the following subjects and course credits: Computer Studies (four credits), ICT (two credits), Technology for Daily Life (two credits), Physical Education (three credits), Lao Culture and Asian heritage (two credits), Lao language Usage (three credits), Mathematics (three credits), and Military Training (one credit).

The fundamental subject group consists of the following subjects and course credits: English Language (10 credits), Political Science (five credits), General Psychology (two credits), Science Curriculum Analysis (four credits), Methodology (three credits), Evolutional and Measurement (two credits), Educational Technology (two credits), Psychology Science (two credits), Physics Methodology (four credits), Vocational experience (three credits), General Education (four credits), General Education Administration (two credits), and Development Psychology (two credits).

The Specific subject group is divided into three parts.

Professional: the subjects and course credits include Mechanics I (three credits), Mechanics II (three credits), Static Electricity and Electricity (four credits), Electric Industry and Electromagnetism (four credits), Thermodynamics (three credits), Optics (four credits), Light Waves (four credits), Nucleus (three credits), Atomic physics (three credits), Astronomy (three credits), Quantum Mechanics (three credits), Electronics (three credits), Solid State Physics (three credits), Fluid Physics (three credits), and Industrial Technology (three credits).

Compulsory: the subjects and course credits include Mathematics 1 (three credits), Analysis Geometry (three credits), Basic Algebra (three credits), Basic Geometry (three credits), Mathematics seminar (two credits), Algebra I (three credits), Biochemistry (two credits), Biophysics (two credits), General chemistry (three credits), Statistics (two credits), Integral Calculus (two credits), and Analysis I (three credits).

The Final Report component is worth two credits and the Teaching Practice component is worth nine credits.

The select Subject group consists of the following subjects and course credits: Machine operating (four credits) or Quantum Mechanics (four credits).

There are 44 credits for 1st year, 41 credits for 2nd year, 43 credits for 3rd year and 32 credits for 4th year, respectively for physics unit, as shown in [1].

II. EXPERIMENT MATERIALS

In October 2015, the physics experiments preparation room of size 3m × 9m was made available. The room contained five desks and chairs and a set of shelves (of size 2m × 1.5m). The room had an air conditioning unit installed in April 2016.

The classrooms were located in the single-floor building. The physics experimental materials were moved from the laboratory storeroom to the designated preparation room. There were 70 items listed on the storeroom register list for physics experimental materials, however, not all item listed were found in the storeroom. Other remaining items were found to be covered with dust and were moved from another storage room by students to the prepared room. Then, the dust was removed and the experimental materials were checked.

The basic measuring tools were checked at the beginning. There was no electronic weighing scale. There were two three beam balances, each had a loading plate and three moving weight beams. One of them was defective because the beam was bent. At least one weighting scale was functional. However, these measuring tools had no instruction manual. The experiments written in the Physics textbooks were revised such that the material required could easily be found, improvised or cheaply produced. Fig. 2 is an example of the 33 rewritten experiments.

The 33 experiments are grouped based on the kinds of equipment the experiment required. These experiments are numbered and discussed in the following:

The first group is the basic mechanics experiments group, which consists of Experiment 1) Mass measure balance, Experiment 2) Length measure micrometer [3], Experiment 3) Length measure Vernier caliper. These are the tools used to

measure the basic physics quantities; [4], [6]. Experiment 4) is mass measurement by balance one, Experiment 5) is mass measurement by balance two. These two experiments are about the hands on measuring tools using the principle of basic torque [11]. Unfortunately, there was no tool to measure time like stop watch. Hence, the experiments that require the use of stopwatches were skipped, which include Experiment 6) the measurement of gravitational acceleration by simple pendulum [7], Experiment 7) the potential energy transformation to kinetic energy [12], Experiment 8) Cone pendulum, and

Experiment 9) Measurement spring constant [9]. Experiment 6) to 9) are the reviews of physics phenomena like simple harmonic motions or gravitational potential energy or energy conservation. Experiment 10) is slipping down box motion on the slope using timing bell, Experiment 11) is the acceleration of free fall using timing bell, Experiment 13) is the accelerated motion on the flat desk. Experiment 10) to 13) include the usage of timing bell. This timing bell was made in Thailand. The experiments are referred from the textbook of experiment as shown [9].

Physics Experiment 1 Basic Measurement


dd/mm/yy / / _____ grade class ID name _____

Experiment 1 mass measurement

Purpose : learning how to use the three beam balance and knowing measuring principle

Preparation : three beam balance, balance weight

Procedure : Set the three beam balance



(1) Set each beam balance 0 respectively.

(2) Check the top of the beam indicate 0. If not, adjust rotating the nut under the plate.

(3) Put the sample weight on the plate and measure the weight from the heavy beam gently.

sample weight [g]	1	2	3	10	20	30	50	100	200	500
Beam Weight [g]										

How do you measure the mass? Write your comments.

Fig. 2 Textbook of mass measurement [3]

The static mechanics problem requires pulley to balance force. Obtaining a small, smooth and cheap pulley in Vientiane is very difficult. Experiment 14) is collision and momentum. The tool used is made of second hand L-shaped pipe frame offered by colleagues.

Some of the experiments' description were revised especially for high schools that do not have basic weighing

scale (when basic weighing scale such as shown in Fig. 2 is not available), to improvise cheaply available materials to create a tool that can measure weight using torque balance principle as shown in Fig. 3. From Fig. 3, the two kinds of demonstrations measure the same target's weight. The left of Fig. 3 shows the holding point is at the center of the rod, whereas the right of Fig. 3 shows the holding point is near the end of the rod. By

measuring the length between the holding point and the standard weight, the target weight can be measured [11].

Experiment 24) is Wheatstone bridge. Two sets of Wheatstone bridge were found only after a handmade Wheatstone bridge was produced using made in Thailand materials [5]. Experiment 25) uses single-phase induction motor, which is to demonstrate changeable rotational direction when combining with four wires. Experiment 26) is about demonstrating a direct current generator. Experiment 27) is about demonstrating a three-phase alternative generator. Experiment 28) demonstrates the function of electromagnet bell or a normal mechanic bell. Experiment 29) was revised to use a capacitance, an ampere meter and a voltmeter to demonstrate charging capacity [8]. Experiment 30) is an experiment using function generator and oscilloscope to measure charging and discharging capacitance. Experiment 31) is a handy generator, which is the active transformation from manpower to electric power. Experiment 32) is current balance. A large amount of time was lost fixing the current balance because the tool does not function effectively; the structure of the tool was modified.



Fig. 3 Mass measurement by balance of two kinds

The third experiment group is wave and vibration. Experiment 40) is standing wave of a string, which consists of two parts – the vibration making, and the resonating string. Although the function generator is available, there was no low frequency amplifier. The improvisation was to use a speaker amplifier and the speaker to vibrate the string; and to have a tool set with two strings to produce resonating string [14]. Experiment 41) is air column resonance. Varying length of air column by using a glass tube, a PET bottle tube, or a plastic tube, the sound produced from the resonance created by a tuning fork in the air column can be heard [10]. Experiment 42) is the hitting of tuning fork against each other. Experiment 43) is grating diffraction of laser beam. The tools used were a bench and a grating learning set. The distances between the beam spots is then measured. Experiment 44) is wave propagation observation. An old overhead projector, a ripple motor and a water tank were used [13]. Some parts of water wave were generated and the wave reflection and interference were observed [13]. Experiment 44) is observing light spectrum using prism. However, this experiment was not conducted due to the lack of the spectrum analyzer and prism.

The fourth experiment group is thermodynamics. Experiment 50) is specific heat of metals [7]. Experiment 51) is Boyle's law. Experiment 52) is heat expansion of the bimetal, and

Experiment 53) is two-stroke engine model. A total of 33 experiments were written for each experiment group as shown in Fig. 4. The revised sections were the purpose of experiment, material preparation, procedures, measuring or observing, writing about the result (numerical tables, pictorial figures), comments or explanation, and problems to consider [15].

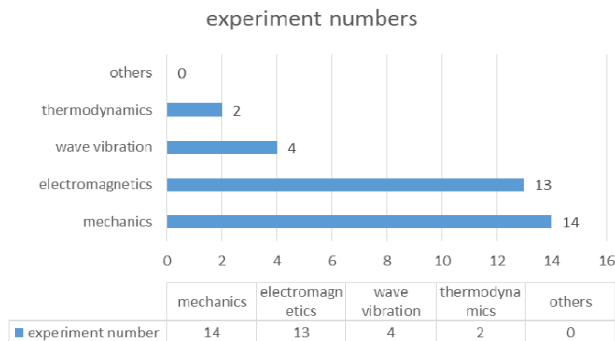


Fig. 4 Experiment textbook created (number of experiment)

After the students attended the experiment class, some students expressed intention to develop other field's experiments as written in the high school textbooks. When conducting the experiment, some students did not measure a few more times to obtain accurate results. While, some students wanted to check the numerical validity of the laws.

Often, the attitude towards learning of the researcher and engineer is overlooked. If there were no experiment class, should one not perform the experiment? The teacher can be the most influential person on the students' learning attitude. Should the physics experiment then be set in the syllabus of the Physics teacher training course? The next problem is the effectiveness of teaching using multimedia – how the materials are used and how the experiments are conducted in class. One good example is Pavy Souvannavong's YouTube channel.

III. MULTIMEDIA

A. YouTube Channel Pavy Souvannavong

Pavy Souvannavong is a Physics teacher for the 2nd and 3rd year students. He mainly teaches three fields – mechanics, optics and fluids. He has enhanced the teaching at the teacher training center by conducting experiments. He not only conducts the experiment inside the classroom, but also perform the relevant experiment outside the classroom. He often introduces interesting physical phenomena to his students by showing them videos or movie clips. In addition, he films the students' presentation to help to train them to become better teachers. From March 2015 to March 2016, he and his students uploaded 102 video clips in Lao language to his YouTube channel [16]. The video clips classified by the Physics fields are shown in Fig. 5.

In March 2015, he uploaded 16 student presentations. There were nine videos about "reflection of mirror," one video about "Refraction by the water," one video about "Extension of light," and one about "Angle measurement of reflection."

In April 2015 he uploaded three videos – Reflection of concave mirror, Reflection of curved mirror, and Reflection of light by curved mirror. The length of the videos ranges from one minute and 15 seconds to five minutes and 11 seconds, and most videos are shorter than two minutes.

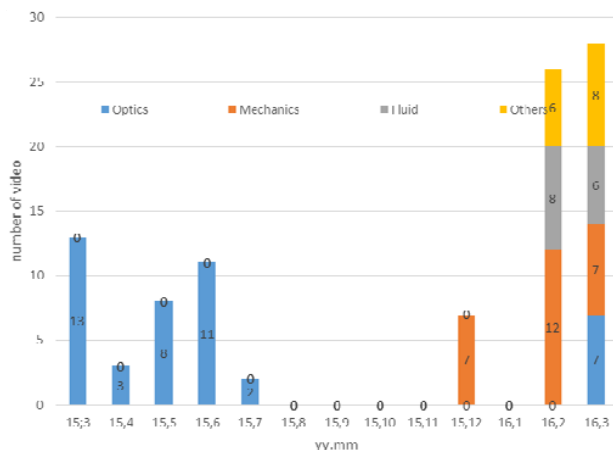


Fig. 5 Pavy Souvannavong YouTube Channel upload numbers

In May 2015, he uploaded videos about refraction. On the May 28, 2015, a student opened a YouTube channel named Stardao Sengthip and uploaded about seven refraction experiment videos in the style that was similar to Pavy Souvannavong's. In some videos, the student showed triangle and rectangle glass refraction. Glasses were attached to the paper; on the paper the passing of light was briefly described.

In June 2015, Pavy Souvannavong uploaded 11 videos. They showed the telescope made of two convex lenses and explained the Physics principle by writing on a white board. On the other hand, among the videos uploaded by his students, two students demonstrated the lens principle by using cardboard box and smartphone light. In addition, student named Xaiyavong Bodsabang uploaded a video on his own YouTube channel about Refraction, showing the angle measuring tool of refraction.

In July 2015, Pavy Souvannavong uploaded two videos about hands-on mirror demonstrations.

In December 2015, his student uploaded a video titled "Animation with flying dandelion seed" in YouTube Channel named NitharSST. A student named Stardao Sengthip uploaded another six videos about mechanics, four of which showed the hand written explanation of "Newton's law," and two of which showed practical videos on the falling motion using a timing bell to observe "Newton's law."

In February 2016, seven students uploaded a total of 25 videos to their own YouTube channels. Nith Sidaphone uploaded three "Paper craft making" videos. Saiyphet thaveevanh uploaded "The coin falling motion" video. He measured time and explained about constant velocity motion by writing on the board. He also showed "the Bernoulli's law" by blowing a ping-pong ball to float in the air. A student's channel named SS Computer had six videos – "Clockwise rotation,"

"Candle sacking water," "Product of nine," "Newton's 2nd law," "Reduction of the friction by cardboard," and "Falling down." These videos had the students demonstrated the experiment and explained the principles on the whiteboard at the front of the classroom. Another student channel by VienVang has uploaded videos that were not filmed in front of the classroom's white board, but which had his own research theme. His videos are "Moving machine arms by water pressure," "Competition of raw egg and cooked egg" (relating to the field of fluid), "Impulse and stopping time" (relating to the field of mechanics) showing himself falling from a tree, "The sound of wired phone" where the wires were made of iron. The making of videos has enriched the students' research activities.

On March 2016, 30 videos were uploaded to eight different students' YouTube channels. The student channel of Leechanya Noryeng had a video titled "Pressure of air." The video showed two plastic cups attached to a balloon demonstrating air pressure. A video titled "Not split water" shows a long needle piercing a plastic bag full of water without any water leaking. A video titled "Moon waxes and wanes" modelling the lunar phase by casting the model earth's shadow whose topic is related to the field of geometry. In her video titled "Telescope", she showed her telescope which was made from a light paper pipe. Her video titled "Refraction of water and oil" showed her pouring water and oil into a cup. A student's channel named Malaphone Songphachan had a video titled "Water surface tension" which showed the water surface tension of the cup when coins were put into water. A video titled "Refraction" showed the coin under a cup filled with water. A video titled "Full reflection" showed the light went along with the falling water leaking from the hole in the bottle. A video titled "Soda flow out," which was related to the field of Chemistry, showed the over flowing of carbonated drink after a soda cake is added to the drink. Another student channel, named Noy, included two videos demonstrating vector addition where the student explained by writing on paper. That was the videos related to the field of mathematics and physics. A student's channel named Phat PTV had a video titled "Old type lampbulb". The video showed a light bulb covered with open spots acting like lampshades. A video titled "Without pressure" showed no water flow out from the pet bottle cut line on the side fixed cap with full water. A video titled "Write and read" showed the written letters with acid became readable when heated. This video is related to the topic in the field of chemistry. A video titled "Angle 360 mirror scope" showed the use of a flexible rotating pipe telescope and mirror. A student's channel named Phit Sengthip uploaded a video titled "Average speed," which explained the mechanics principles by writing on the white board with BGM. A student's channel named SS Computer had uploaded 10 videos. A video titled "Balance using screw" showed the balance combined with a screw. A video titled "Easy way to cut the glass bottle" showed how to cut the glass bottle using strings, oil and fire. A video titled "Density of water and oil" showed the difference between the density of oil and water within the bottle. A video titled "Chair made of PET bottles" showed how to make pet bottle joint

chair. A video titled “Street board” showed a screen made by transparent vinyl sheet hanging on the wall along the street. Five other videos titled “Transformation and deliver”, “Mass and weight”, “Recipe of physical movement,” “How to remember sin and cos,” and “Separation of force” are that videos of a student explaining the Physics principles on paper. A student’s channel named Stardao Sengthip had a video titled “Float on the water” which showed the density of an egg in salt water. A student’s channel named Tuskuvtseemhlab Mustagtiam had a video titled “Moon waxes and wanes” which showed shadows cast on the models of the sun, the earth and the moon. A video titled “Double reflection” showed the double reflection of a laser beam pointed on the wall of a bucket when more water was added to the bucket. There were two laser beam spots – one above the water line, and another below the water surface in the bucket. The video also provided an explanation of the phenomenon.



Fig. 6 Uploaded movie “Lens” [16], [17]

After June 2015, the YouTube channel of Souvannavong had no new videos uploaded. In contrast, the student channels had uploaded videos of their presentations, class reports, and the research topics chosen by themselves. These showed the progress of Souvannavong’s teaching methodology. Most of the videos uploaded were the student’s reports presented in front of the class, as shown in Fig. 6.

Nowadays, the smartphone is popular and useful. YouTube is one of the many educational websites; however, the videos can be open to public and for the protection of intellectual property or otherwise become public, then probably the choice of using a network database is a better alternative. If making videos is the path to embark on, then knowing how to produce quality videos will be very useful. The YouTube Channel “Science for Lao” is a good example.

B. Science for Lao

At the beginning, there were three people. Their specialized subjects were Physics, Chemistry and Biology. They all worked as volunteer at the teacher training colleges in Laos. Their initial thought that there were plenty of facilities in their colleges, but there were little facilities in the high school in rural areas. Therefore, if they were to upload the video of experiments in the Lao language, many teachers and students could watch the videos and understand the phenomena easily. Therefore, the science education group of JOCV in Laos has

begun to upload videos since December 19, 2015 on the YouTube channel named “Science for Lao” [2], and although it is small channel, it is developing. There is limited content related to physics. The videos uploaded were, “paper made fan rotates by warm hands,” “coupled vibration,” “clip motor,” “electric current and magnetic field interaction,” “Let’s make a sunset,” “Leiden Jar,” “specific heat,” “grating diffraction of laser beam,” “organic indicator,” “ammonia fountain,” “Iodine gas,” “burn ion color,” “Melting point of solid,” “Frog dissection,” “Smart phone microscope,” and “organic waste compost.” The videos were presented using slides, which was a simple concept. They divided the video into three parts – beginning, performing and ending.



Fig. 7 Science for Lao title slide of grating diffraction [18]

Taking the grating diffraction video as an example, for the beginning part contained PowerPoint slides. The first slide showed the group logo and the title, as shown in Fig. 7. The second slide showed the purpose of the experiment. In this case, the purpose was to observe the diffraction phenomena, to review the learning of grating diffraction, and to calculate the wavelength of laser beam using diffraction conditions. The third presented the materials required for the experiments. In this case, the materials were a laser beam, a grating and a ruler. The slides that followed described the procedures.

The procedure steps written on the slides were as follows:

1. Set the laser beam projector.
2. Set the grating on the long chair. Students can use the lattice constant from the grating set, 100 line/mm, 300 line/mm and 500 line/mm.
3. Set the length 1.00 m between the grating and the screen using a wall.
4. Turn on the laser beam.
5. Measure the beam spot distances from the center spot using ruler.

At the beginning, the video starts with three PowerPoint slides and the authors often add pictures to offer a better explanation. The fourth slide is an advisory slide, where the authors can write a warning, such as “Not to look directly into a laser beam” and “handle diffraction grating films gently.” As diffraction grating film is fragile and can easy tear as it is mounted on a paper frame.

The second part is performing the experiment. This part contains video clips to help the students become familiar with

the steps in conducting the experiment. This section takes up a large capacity of a file. To make the file capacity smaller, this part should be compact and short, or within five seconds.

The final part is the conclusion, which contains PowerPoint slides showing the tables of measurement and the discussion. Some of the questions are listed below:

1. What was the data of this experiment?
2. What do you intend to measure?
3. Do you pay attention to the resulted numbers or statistical treat?
4. How do you explain these phenomena?
5. Can you review mathematical explanation?
6. Can you draw the image picture of that? In this case, movie shows the result tables of spots and explanation of diffraction.

The three parts were combined into one video by converting the PowerPoint slide shows into videos, and then using the video editor to link three videos together.

Students revise and confirm the concepts they learned when preparing the video. The experiment video is very important as it attracts the interest of many students, and furthermore, the video making activity itself is engaging and educational.



Fig. 8 Science workshops at Vientiane High School

On video making, workshops were provided to teachers over two days, March 28th to 30th, 2016. The workshops were organized by the Vientiane High School, ICT division of the Ministry of Education Lao P.D.R. and Science for Lao. After the opening ceremony, the lectures for physics experiment of mechanics and optics showed the acceleration motion of falling using pulley, images made by a lens and its principle, solar cells and moving vehicle, and burning paper using convex lens. Fig. 8 below shows Sekiya, a physics education lecturer who attended the workshop as a volunteer from Japan, who demonstrated burning of paper using convex lens.

Tetsuhiro Yamaguchi introduced how to make science experiment videos as a member of "Science for Lao". He also demonstrated the chemical experiments about indicators or made of purple cabbages, after which audiences made video clips of the experiments. Among the audiences, about 20 of them were the science, mathematics and computer teachers of Vientiane High school. These teachers attended the workshops voluntarily, in addition to their class schedule and other school commitments.

During the workshop, a Vientiane high school member asked

"Science for Lao" to demonstrate the use of physics experiment materials. The school had been supplied new physics experiment materials. The guidebooks were in the Lao language and in English; however, the new materials were made in Germany and were suitable for experiments in the fields of mechanics, hydrodynamics, solar power, optics and electricity. For the authors, it was interesting to learn about the new materials. For example, when someone hung two of the same mass which were connected together with a string through fixed pulley, they stop at any position of any height. That was marvellous. When the experiment about electric circuits was conducted, there was no need to use the connecting wire because the nine holes were connected together by the box surface panel. Some parts were set inside of the transparent box that had three or four pins in it. This is very convenient, as the circuit can be broken or connected at any moment without the use of soldering iron.

On the May 11th, 2016, a small workshop about making videos was conducted at Vientiane High School. There were new experimental materials for Physics and Chemistry, and teachers from Vientiane high school demonstrated the use of a new electric circuit board. The experiment used one light bulb, one switch, one voltmeter, one ammeter, one power supply and a circuit board. The physics experiment was followed by the video making workshop. At the session began with a one-hour lecture about making video clips by two instructors. In the afternoon, those attending the workshop were making videos in the computer room. Every person attending the workshop had the opportunity to make a video clip. At the end of the workshop, they reported the experiments supported by a PowerPoint presentation.

On June 8th and 9th, 2016, "Science for Lao" had a monthly meeting at Louang Namtha Teacher Training College. On the June 7th, one day before the workshop, six hours were spent checking the new experimental materials and five experiments were selected from 29 candidates:

- 1) Water depth and pressure,
- 2) Data logger for temperature and treatise of its data,
- 3) Double slit diffraction of laser beam,
- 4) High voltage and spark, and
- 5) Basic electric principle.

On the June 8th, after an opening ceremony, 29 students were divided into five groups, each group headed by a teacher. The target was to create experiment for new materials to be used in the textbook. The components of the workshop include checking of materials, conducting the experiments and finding answers for the following questions:

1. What is an experiment title?
2. What is the purpose of the experiment?
3. What forecast, assumption or theory do you want to know, check or confirm by the experiments?
4. What quantities will you measure?
5. After performing the experiments,
 - a. How do you show the materials and experiment procedure?
 - b. How will you show the result?
 - c. What are your comments?

The students were prompted with these questions as the time of the workshop progressed. At the end of the day, the students present their new material experiments.



Fig. 9 Science festival instructor workshop at Louang Namtha Teacher Training College

On June 9th, 2016, a science festival for kid's instructor workshop was held in the morning. The game stations were 1) Soap balloon, 2) Slime, 3) Fog spray, 4) Rotating two liquids, 5) Bazooka horn, 6) Hark balance, 7) Air cannon, 8) Ping pong ball blow, 9) Bye-bye pendulum, and 10) Clip motor. These game stations were enjoyable, amusing, and engaging activities for kids. For each game station, the individuals in charge offered a 15-minute explanation about the experiment. There were three or four people in charge of each game station. The material supplied were 40 sets for each experiment or each game station. The event began with an approximately three-hour lecture. In the afternoon, 10 booths were set along the building corridor. This science festival was open to anyone attending the college. Unfortunately, the organizer did not contact the model primary school, so there were no primary aged children attended. On the other hand, students from other departments attended the festival as guests and took part in instructions and experiments, as shown in Fig. 9. This was a new approach to teaching which can be included in the activities for an outreach program. From this practice, the style of the report for the experiment class was adapted from the experiment videos uploaded on the Science for Lao channel.

C. e-Learning Class

YouTube is an open channel, and therefore, caution needs to be taken when publishing videos. Hence, a closed group e-Learning is a useful option. This system allows limited access only for members who know each other and share the same purpose of learning. Users can learn not only in a classroom, but also from anywhere. The facility for closed group e-Learning is available, however, the procedures and structures are rather confusing, and the facility capacity is also limited.

In Dongdok campus, IT center has an e-Learning platform. In faculty of engineering at Sokphaluang Vientiane, and there is a platform donated by Japan to the computer department.

The IT center in Dongdok campus has many computer units donated by KOICA. The e-Learning system of the IT center began to take shape; this system is known as Moodle (<http://lms.nuol.edu.la/>) and contains two courses – bachelor courses and master courses.

Under the Bachelor course (<http://lms.nuol.edu.la/course/category.php?id=14>), there are some sub categories namely mathematics, letters, economics, agriculture, engineering, forestry, social science, training, architectures, law, miscellaneous, education and others. The physics experiment class was added so as to enable to use of e-Learning system for physics experiments. Since there was no formal academic credit allocated for physics experiment class, this class is then a part of physics teacher Syhalath's second year student's class.

The first page on the e-Learning platform of the physics experiment class was an introduction with a welcome message and steps on how to navigate the module. The second page is the log in page to enter the class. The individuals who can log in include the channel moderators, teachers, non-editing teachers, students, and guests. Under the edit course setting, the general setting has many fields – course full name, course short name, course ID number, course summary, format, course start date, new items to show, grade book to students, show activity reports, maximum upload size. In formatting options, for weekly format, there are number of weeks/topics, and course layout. Under guest access, a guest is also required to use a password to access. In Groups setting, there are group mode, force group mode, default grouping and availability to students, language, and role renaming.

After system setting is layout selection. Many layouts can be selected. In this case a weekly layout was selected. Then activities and resources were added. There are many options for activities – assignment, chat, choice, database, external tool, forum, glossary, lesson, quiz, SCORM package, survey, wiki, and workshop. There are many options for resources – book, file, folder, IMS content package, label, page, and URL, as shown in Fig. 10.

In April 2016, the trial class of physics experiment for year two students began. At the beginning of the class page, the PowerPoint presentation templates and textbook files were offered.

In our case, one class was divided into five groups. For the first experiment class, each group receives a different experiment textbook and students can download the files and prepare for class.

Our network activity is on-line, and the sharing of information and discussion were encouraged via this on-line communication channel. Ultimately, the students are to report the experiment, and in order to do that, the students have to perform the experiment themselves. As shown in Fig. 11, the students take pictures and record videos of their experiments. The students then complete the PowerPoint slides to support the report about their experiments using the templates provided.

The beginning section of the presentation, the students were required to write the purpose, materials, procedure, and discussion. The second section of the presentation, the students

were required to take pictures or record video files for the experiment they performed. The last section of the presentation includes the experiment results, explanation, problems or

questions. They have to submit these three parts after presentations.

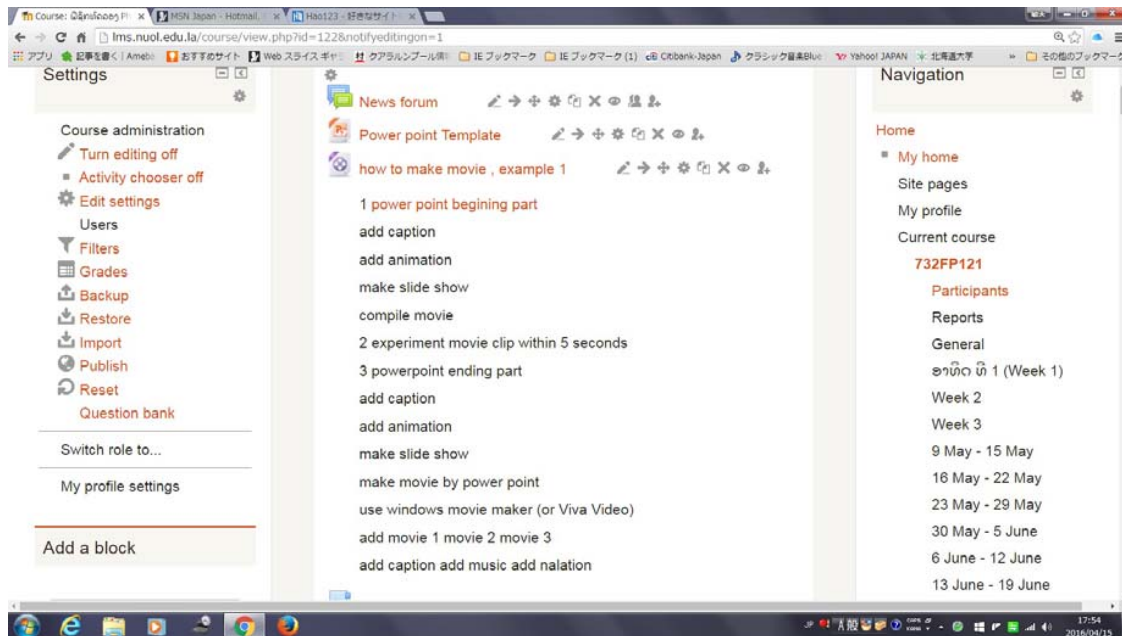


Fig. 10 e-Learning class page making view



Fig. 11 Physics experiment class activities

Unfortunately, there was no Internet connecting system in the classroom. Private Wi-Fi was used to connect to the Internet in the classroom. One projector and one laptop computer were donated by JICA.

At the beginning, the students were faced by many problems, including the following technical issues:

1. The students were confused about logging-in and downloading files.
 2. The students could not read the experiment textbook as they did not have the right application in their smartphone.
 3. The students could not download the sample movie file.
 4. The students did not know how to edit the downloaded PowerPoint files.
 5. After editing the files, the students could not upload files.
- The teachers were concerned that the students could not

understand the experiment, and the technical issues required students to have some experience, which took some time to overcome.

Each of our experiment classes were divided into three sessions. Each session is 90 minutes. For one experiment, three sessions or 270 minutes were required.

For the first physics experiment class, each group received different textbook. During the first session, the students confirmed the title of the experiment and checked it against the experimental materials they required. They took pictures of the materials and rechecked it against the experiments written in the textbook. During the second session, each group performed the experiment, as shown in Fig. 10. Each group obtained the experiment data and the results, and recorded video clips of the experiment. After that, the students made their PowerPoint slides presentation. During the third session, each group showed the class their experiment using the PowerPoint presentation they had prepared. The students showed the learning content and their practical experiences. The students also held discussions among their group members or with other students in the class.

The students were willing to attend the class and actively participated in all class activities. After giving the PowerPoint presentation, the students had to upload the presentation files to the e-Learning site. This is the final activity of the experiment, as shown in Fig. 12.

At the beginning of this trial class, the students could not submit the video clips because of the physical limitation of the e-Learning site, which had limited capacity.

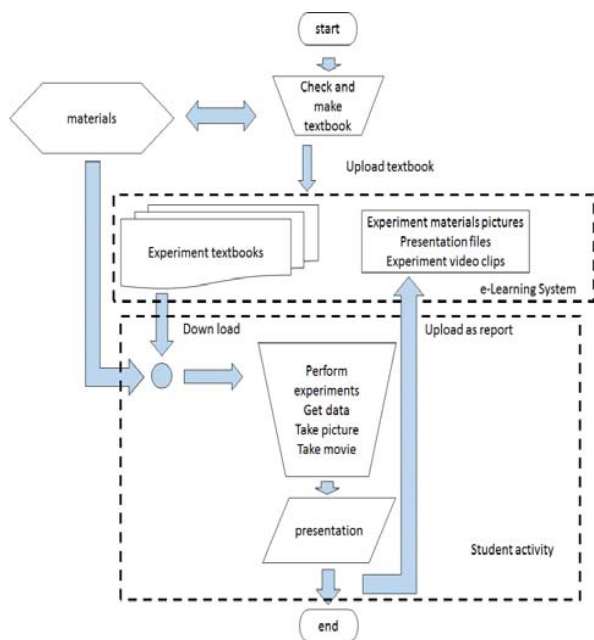


Fig. 12 Physics experiments class using multimedia scheme

IV. CONCLUSION

In the NUOL, the high school Physics teacher training course did not have enough teaching resources, including the course syllabus. Nevertheless, the available resources were identified and assessed, and the curriculum was revised and tailored to the available materials. Although, the available resources are limited, 33 experimental textbooks were created, and include; 15 related to the mechanic’s field, 13 related to the electromagnetic fields and six related to wave or other

experimental fields. The number of materials available for each textbook experiment is very limited, which meant that not all the students could perform the same experiment at once. Plural group learning is an effective way of learning in an environment with limited and insufficient resources and facilities. In our case, five groups undertake five different experiments at the same time. In addition, then group that had previously performed an experiment could guide or advise other groups. This is a way of learning by teaching.

The presentation style was adopted from the video produced by the Science for Lao YouTube channel, and contained the title, purpose, materials, procedure, attention, performance, result and comments, which are effective sections for learning.

By using the e-Learning system, the experiment textbooks and presentation templates were distributed. Then students could submit the reports using the platform, and they could learn how to make video clips from the content shared on the e-Learning platform. An experiment resource centre will also be created from the work contributed by the student.

In 2016, the Department of Natural Science, Faculty of Education, NUOL received the budget of USD 28,000 for new experiment materials for the Physics, Chemistry and Biology departments. As for physics, 23 pieces of equipment and materials were delivered. Two new experimental textbooks can be created for these new materials, making the total number of Physics experimental textbooks developed to 35.

TABLE I
TEACHING PLAN FOR PHYSICS EXPERIMENTS SUBJECT SEMESTER1-1

class	W1	W2	W3	W4	W5	W6	W7	W8
1A	O	T1d	T1e	T1p	T2d	T2p	T2e	T3d
1B	O	T1d	T1e	T1p	T2d	T2p	T2e	T3d
2A	O	T11d	T11e	T11p	T12d	T12e	T12p	T13d
2B	O	T11d	T11e	T11p	T12d	T12e	T12p	T13d
3A	O	T21d	T21e	T21p	T22d	T22e	T22p	T23d
4A	O	T31d	T31e	T31p	T32d	T32e	T32p	T33d
4B	O	T31d	T31e	T31p	T32d	T32e	T32p	T33d

1A=1st grade student class A,
W1=Week1, O=Orientation, T1d=group1 Textbook1 download, T1e=group1: Textbook1 experiment, T1p=group 1: Textbook1 presentation,
T1x= group1 perform Textbook1, group2- Textbook2, group3- Textbook3, group4- Textbook4, group5- Textbook5, 1-5 cyclic respectively like:
T2x=group1 perform Textbook2, group2 Textbook3, group3 Textbook4, group5 Textbook1.

TABLE II
TEACHING PLAN FOR PHYSICS EXPERIMENTS SUBJECT SEMESTER1-2

class	W9	W10	W11	W12	W13	W14	W15	W16
1A	T3e	T3p	T4d	T4e	T4p	T5d	T5e	T5p
1B	T3e	T3p	T4d	T4e	T4p	T5d	T5e	T5p
2A	T13e	T13p	T14d	T14e	T14p	T15d	T15e	T15p
2B	T13e	T13p	T14d	T14e	T14p	T15d	T15e	T15p
3A	T23e	T23p	T24d	T24e	T24p	T25d	T25e	T25p
4A	T33e	T33p	T34d	T34e	T34p	T35d	T35e	T35p
4B	T33e	T33p	T34d	T34e	T34p	T35d	T35e	T35p

TABLE III
TEACHING PLAN FOR PHYSICS EXPERIMENTS SUBJECT SEMESTER2-1

class	W1	W2	W3	W4	W5	W6	W7	W8
1A	O	T6d	T6e	T6p	T7d	T7e	T7p	T8d
1B	O	T6d	T6e	T6p	T7d	T7e	T7p	T8d
2A	O	T16d	T16e	T16p	T17d	T17e	T17p	T18d
2B	O	T16d	T16e	T16p	T17d	T17e	T17p	T18d
3A	O	T26d	T26e	T26p	T27d	T27e	T27p	T28d
4A	-	-	-	-	-	-	-	-
4B	-	-	-	-	-	-	-	-

TABLE IV
TEACHING PLAN FOR PHYSICS EXPERIMENTS SUBJECT SEMESTER2-2

class	W9	W10	W11	W12	W13	W14	W15	W16
1A	T8e	T8p	T9d	T9e	T9p	T10d	T10e	T10p
1B	T8e	T8p	T9d	T9e	T9p	T10d	T10e	T10p
2A	T18e	T18p	T19d	T19e	T19p	T20d	T20e	T20p
2B	T18e	T18p	T19d	T19e	T19p	T20d	T20e	T20p
3A	T28e	T28p	T29d	T29e	T29p	T30d	T30e	T30p
4A	-	-	-	-	-	-	-	-
4B	-	-	-	-	-	-	-	-

In June 2016, a space was granted for the physics experiments class. Even though facilities like desks and chairs were lacking, the physics experiment class using multimedia has been prepared.

Seven experiment classes were planned to begin in September 2016 – two classes for the first year, second year and the fourth year students, and one class for the third year students. A total of 35 experiments were prepared for all students during their seven semesters for the four years of Physics teacher training education. Each semester has 16 weeks, starting with the first week of orientation, and 15 weeks for the five experiments, with one session per week. Three sessions are required for one experiment – beginning, performing the experiment, and presentation. Refer to the teaching plan tables.

After, NUOL requested JICA volunteer to begin physics experiments class using multimedia, the problems that were resolved were preparation of the laboratory room, teaching materials, teaching textbooks, experiment and presentation, report, information system, report submission system and physics laboratory space. At the end of the preparation, the physics experiment curriculum is to be made formal. Then authors have reached the beginning stage of physics experiments class utilising multimedia; however, more research and improvement for this teaching system is required in the future.

Experiment facilities are limited at schools in Laos; however, the authors believe the beginning of the proposed system can contribute to the teacher training course in Laos. The authors also hope that the students will practice the experiments in class using multimedia, which can enhance and stimulate their learning and studying Physics at high school and as teachers of the future.

Future work by the authors can assess the quality of the class, and if the classes provide the students with the necessary knowledge and capabilities to solve unknown problems.

ACKNOWLEDGMENT

T. Nagata and the other authors wish to thank the Faculty of Education, National University of Laos, Staffs of Department of Natural Science of Faculty of Education of National University of Laos, ICT Center of the Ministry of Education and Sports of Lao P.D.R., Vientiane High School, JOCV Education Group, the staff of the JICA Laos office, and the Natural Science Experiment group of Faculty of Science of Hokkaido University in Japan, as well as the Hokkaido Science Education Center attached to Hokkaido Education Research Institute in Japan, Nongovernmental organization Hokkaido Science Activity Network in Japan, and finally, JICA Laos Volunteer coordinators.

REFERENCES

- [1] Ministry of education and sports, Academic physics teacher curriculum for secondary teachers (from 1 year to 7 year), Department of Education, Lao, written in Lao, 2013 pp6-8.
- [2] Tetsuhiro Yamaguchi, Akemi Suenaga, Suguru Kashima, Toshio Nagata, "Science for Lao", https://www.youtube.com/channel/UCtP6trBtpjTd-tdQIO_mb2w, 2015
- [3] Panyak Lek et. al. "Laboratory Physics 1," Sripatum University, Thailand, written in Thai, 2011, pp 13-53.
- [4] Physics Science committee, "Guide book physics laboratory 1" Mahasarakham University, Thailand written in Thai, 2010, pp3-35.
- [5] Physics Science committee, "Guide book physics laboratory 2" Mahasarakham University, Thailand Written in Thai, 2010, pp1-13.
- [6] Physical Science committee, "General physics experiments" Mahasarakham University, Thailand Written in Thai, 2010, pp1-10.
- [7] Khom Pesith Syhamat, "physics 1 for engineer, laboratory undergraduate level physics 1" Faculty of engineering, department of physics, Racha Mungkhon Esane University, Khonken Campus, written in Thai ,2011, pp3-91.
- [8] Khom Pesith Syhamat, Sayan Phokeo et. al. "physics 2 for engineer, laboratory undergraduate level physics 2," Faculty of engineering, department of physics, Racha Mungkhon Esane University, Khonken Campus, written in Thai ,2012, pp14-53.
- [9] Lem Thong Landavong, Soun Thone, Seng Souritavong, "Laboratory, physics basic laboratory 1 for TTC 11+3 year 2," Teacher development center, Ministry of Education, Laos, Written in Lao ,1998, pp9-83.

- [10] Visith Kisanaphuti," Guide book physics laboratory basic 1 and 2" department of physics, Faculty of science, Khonkone University, Thailand, written in Thai ,1988, pp42-79.
- [11] N. K. Lowe, "Low cost Equipment for Science and technology education," UNESCO, 1985, Volume 2, Part 1.
- [12] Nathana Unterman, "A teachers guide, Amusement Park physics," J. Weston Walsh Publisher, USA, 1990, pp8-9.
- [13] Eiji Nakamura, Yasukazu Yoshizawa, "New pictorial Physics," Daiichi gakushyushya, Japan, written in Japanese, 2010, pp66-76.
- [14] JunichirIt Nakahara, et. al. "Natural Science laboratory," Hokkaido University, Japan, written in Japanese, 2014, pp2-62.
- [15] S. Xaphakdy, Toshio Nagata, et. al. "Refresh physics materials and Practice in National University of Laos" ICEP 2016 Singapore, 2016
- [16] "YouTube Channel Pavy Souvannavong," <https://www.youtube.com/channel/UCSzSuzEtMw02Dq-Tj1kwCGw>, 2015
- [17] "YouTube Channel Pavy Souvannavong." <https://www.youtube.com/watch?v=z2YmoB1V09c>, 2015
- [18] "YouTube channel Science for Lao," <https://www.youtube.com/watch?v=pdSdwKGwy-k>, 2016
- [19] Nobuyoshi Nishizawa, Hisatsugu Furukawa, Yukio Kiuchi, "Development and International Cooperation of Laos," Mekong Publishing , Japan, written in Japanese, 2003, pp15-314.