American Journal of Sciences and Engineering Research

E-ISSN -2348 – 703X, Volume 7, Issue 3,

Building Teaching Topic Integrated with Stem (iSTEM) Level 1 "Designed & Assemble Decorative Light"

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Abstract: *Teaching science subjects (Physics, Chemistry, Biology) with an integrated approach and integrating with Technology, Informatics, Mathematics subjects into lessons or topics (called in international language is an integrated STEM lesson or topic), abbreviated as iSTEM (intergrated STEM). This is one of three forms of STEM education organization and also the main form, mass implementation for all high school students in Vietnam.*
In this article, we apply the research results on the criteria and process of building iSTEM topics (Pham Thi Phu & Le Thinh, 2022a) to design the iSTEM level 1 topic and organize subject teaching in the framework of pedagogical experimentation.
Research methods: Document research, Model proposal, Model operation, Pedagogical experiment.
Achievements: Level 1 iSTEM topic teaching dossier set "Designed decorative light circuits assembly"

Keywords: *iSTEM teaching topics; decorative lights circuits.*

I. Approach

The iSTEM topic gathers knowledge and skills from the four fields of Science, Technology, Engineering and Mathematics to solve practical problems; The topic of iSTEM is very diverse, there are many ways to classify depending on how the classification sign is selected.

We categorize iSTEM topics based on the areas of Science involved in problem solving; in the field of Science (S) there are Physics, Chemistry, Biology; Therefore, we classify iSTEM topics into the following three levels: Level 1. Scientific knowledge as a theoretical basis for problem-solving only mobilizes one subject in three subjects Physics, Chemistry, and Biology; Level 2. Scientific knowledge mobilized from two of the three subjects mentioned above; Level 3. Scientific knowledge needs to be mobilized from all three subjects of Physics, Chemistry, and Biology. Levels 1 and 2 are parts of the iSTEM topic, level 3 is full iSTEM topic.

This article publishes the results of applying the iSTEM topic development process proposed by us in (Pham Thi Phu & Le Thinh, 2022b) to build iSTEM level 1 topics, applied to teaching Physics in high schools, topic name "Designing and assembling decorative lights".

II. Research content and results

2.1. Building a theoretical framework for the topic of iSTEM teaching

We have built a theoretical framework for teaching iSTEM topics (Pham Thi Phu & Le Thinh, 2022a, 2022b), for convenience, the main results are listed (see Table 1).

 Received-20-05-2024, Accepted- 29-05-2024

Table 1: *Criteria and process for designing iSTEM teaching topics*

Steps	Content	Criteria
Step 1. Identify the problem	- Look for real-life scenarios to create a problem situation; - Proposing the problem	**Target Criteria (Criteria M)** - Fascinating, motivating context - Technical design challenge
Step 2. Identify the product/technology solution that can solve the problem	- Naming technology products/solutions - Find out similar products/technology solutions already on the market, evaluate advantages and disadvantages - Developing a system of standards and criteria for products/technology solutions - Design evaluation sheets of technology products/solutions	**Evaluation Criteria (Criteria D)** - Product review plan
Step 3. Identify background knowledge	- Gather knowledge of science and math subjects as a basis for designing, manufacturing and operating technology products/solutions (drawing diagrams of the relationship between background knowledge and products (CFG); - Identify the place of each knowledge in relevant science subjects (Physics, Chemistry, Biology), Technology, Informatics and Mathematics in the educational curriculum.	**Objectives and Content Criteria (M&N Criteria)** Draw diagrams linking products or technology solutions and knowledge in subjects S, T, E, M (CFG)
Step 4. Determine the teaching objectives of the topic	- Determine the target of knowledge and skills according to the curriculum of the subjects mentioned in step 3. - Identify other competency goals.	**Criteria M**
Step 5. Build a set of product-oriented questions	Build a set of product-oriented questions based on the learning process organized according to the technical design process.	**Method Criteria (Criteria P)**
Step 6 Design the process of organizing learning activities	Design activities of groups of students according to the technical design process: (1) Identify the problem - (2) Find out the background knowledge - (3) Propose designs - (4) Discuss and choose the design - (5) Manufacturing the product - (6) Product presentation, evaluation - (7) Design adjustment, product adjustment.	**Criteria P, Criteria of Organization (Criteria T)**
Step 7 Design a plan to evaluate learning outcomes according to the objectives in Step 4	- Design tools to evaluate subject capacity goals (Awareness, Understanding Science, Application); - Design a tool to evaluate common competency goals - Develop a plan to use evaluation tools	**Criteria D**

2.2. Building the iSTEM level 1 teaching topic "Design and assemble decorative lights"

Step 1. Identify the problem

During holidays such as Vietnamese Teachers' Day/Christmas/Tet/birthday, ... We need to decorate the classroom/house to sparkle the night of the meeting, with the products we design and manufacture.

Preparing for Christmas and New Year holidays, order for grade 11 students to decorate their classrooms with decorative lights that they designed and assembled themselves to ensure sparkling, unique and environmental friendly. (The problem is posed in the context of motivating, engaging and stimulating students to overcome technical design challenges: designing and assembling products that are both sparkling and unique (not yet in practice), and environmental friendly.

Step 2. Identify the product/technology solution that can solve the problem

Product name: Decorative lights

Survey products on the market: LED decorative lights, incandescent decorative lights, compact decorative lights, evaluate the advantages and disadvantages of decorative lighting products on the market (see Table 2)

Table 2: *Types of decorative lights on the market*

TYPE	Wattage	Durability	Longevity	Environmental friendly	Save electricity	Price
Led	Low	High	High	High	High	Low
Incandescent	High	Low (Fragile)	Low	Average	Low	Average
Compact	Average	Low (Fragile)	Average	Low (Flammable, contains mercury)	Average	High

- Define product criteria (see Table 3)

Table 3: *Criteria of decorative lighting products*

Standard	Criterion of product	Score
1.Function	TC1. Multicolor (brilliant), TC2. Flashing (shimmer) TC3. Use green energy (renewable energy) TC4. Green materials and technology (recycled materials)	10 point 10 point 10 point 10 point
2.Visual	TC5. Unique (not yet on the market) TC6. Easy to use TC7. Easy to transport and store TC8. Spectacular	10 point 10 point 10 point 10 point
3. Safe for users	TC9. Safe use of electricity	10 point
4. Price	TC10. Reasonable price	10 point

Design evaluation sheet for product presentation (see Table 4)

Table 4: *Product presentation evaluation sheet*

Standard	Criterion of product	Score
Layout *(5 point)*	P1. Introduction P2. Learn about all the available products P3. Scientific basis of the product P4. Circuit diagram and product design P5. Product manufacturing P6. Product Operation	0,5 point 0,5 point 1 point 1 point 0,5 point 0,5 point

Content *(50 point)*	*P2. Learn, investigate, research (structure, operating principle, function and cost) according to the number of products on the market.*	5 point
	P3. Scientific basis (Power source, current, Ohm's law, semiconductor, components...)	
	P4. Circuit diagram and design drawing according to level of quantity, content and technique	25 point
	P5. Equipment selection, module manufacturing, assembly structure, product packaging	10 point
		10 point
Report *(45 point)*	*P6. Product operation (product demonstration according to the requirements)*	10 point
	Visual (clear text)	5 point
	Style (confident, agile, decisive)	5 point
	Language (clear, concise, easy to understand)	5 point
	Answer the question (sufficient, correct content)	5 point
	Make questions (clear, to the point and content)	5 point

Step 3. Identify background knowledge (see Figure 1)

- Diagram of knowledge connection integrated STEM level 1, subject "Decorative lights" belongs to the Physics subject

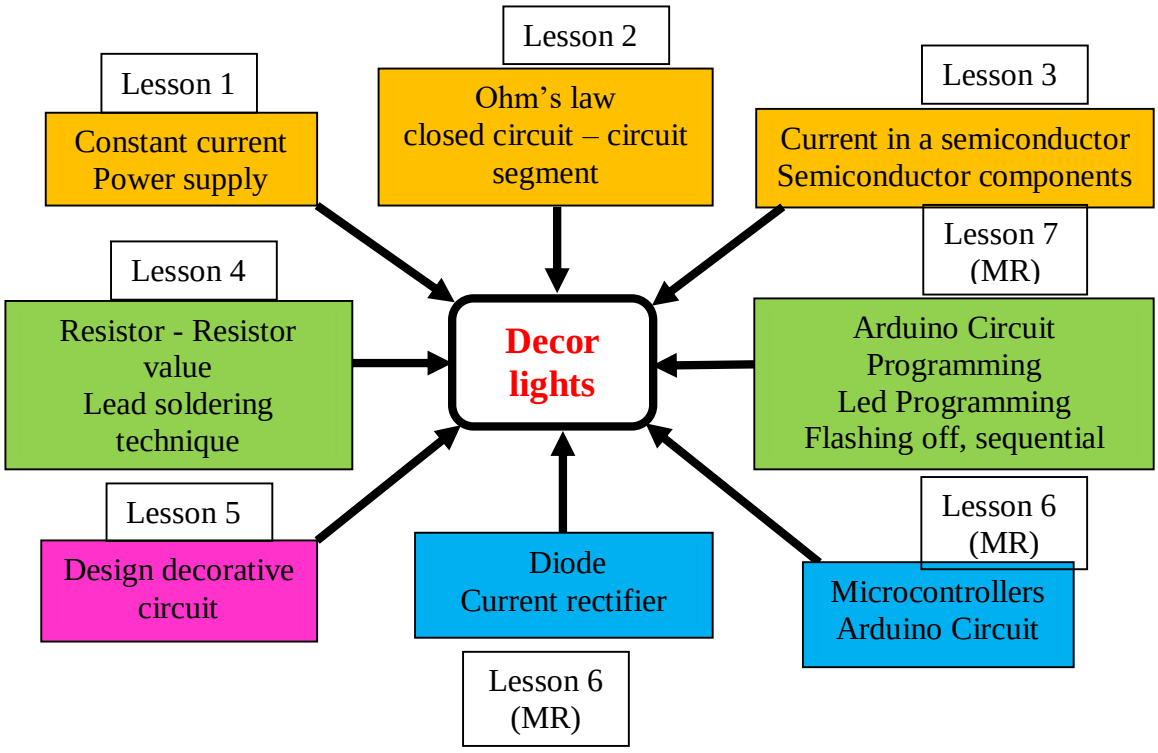


Figure 1: *STEM knowledge diagram with products (CFG)*

Step 4. Determine the teaching objectives of the topic. (see Table 6)

Table 6: *Teaching objectives of the topic*

TEACHING OBJECTIVES	
❖ **Development:** Physical Competence, Problem Solving and Creativity, Self-study, Communication and Cooperation	
Knowledge	▪ Physic - Apply knowledge of power sources, power coupling, Ohm's law for circuits, semiconductors, leds to create products ▪ Technology + Use voltmeter to check power, battery, measure voltage. + Use Ampere meter to measure current when designing electrical circuits + Electrical circuit design and simulation software ▪ Technical: + Distinguish the poles of led, power supply + Apply lead soldering techniques for connecting wires. + Determine the value of the color ring on the resistor ▪ Mathematics: Students apply math knowledge to design electrical circuits, determine the number of sources that need to be assembled to provide voltage and amperage corresponding to a given number of leds.
Skill	- Classify sources and perform power pairing according to usage requirements - Distinguishing component pins, Led, power poles - Design, assemble and connect components in the light circuit - Use tools proficiently such as Voltmeter, Ampere meter, soldering iron - Programming, coding the effect of flashing decorative lights
Quality	- Active in learning, designing and creating products - High spirit of cooperation, willing to listen to the opinions of team members - Careful and meticulous in experience activities and strictly comply with occupational safety regulations in experiments, practice and research.

Step 5. Build a set of product-oriented questions

Introductory question:

- How to create a decorative light that is both shimmering and colorful while using energy and environmental friendly materials?
- What types of lights are often used for decoration?

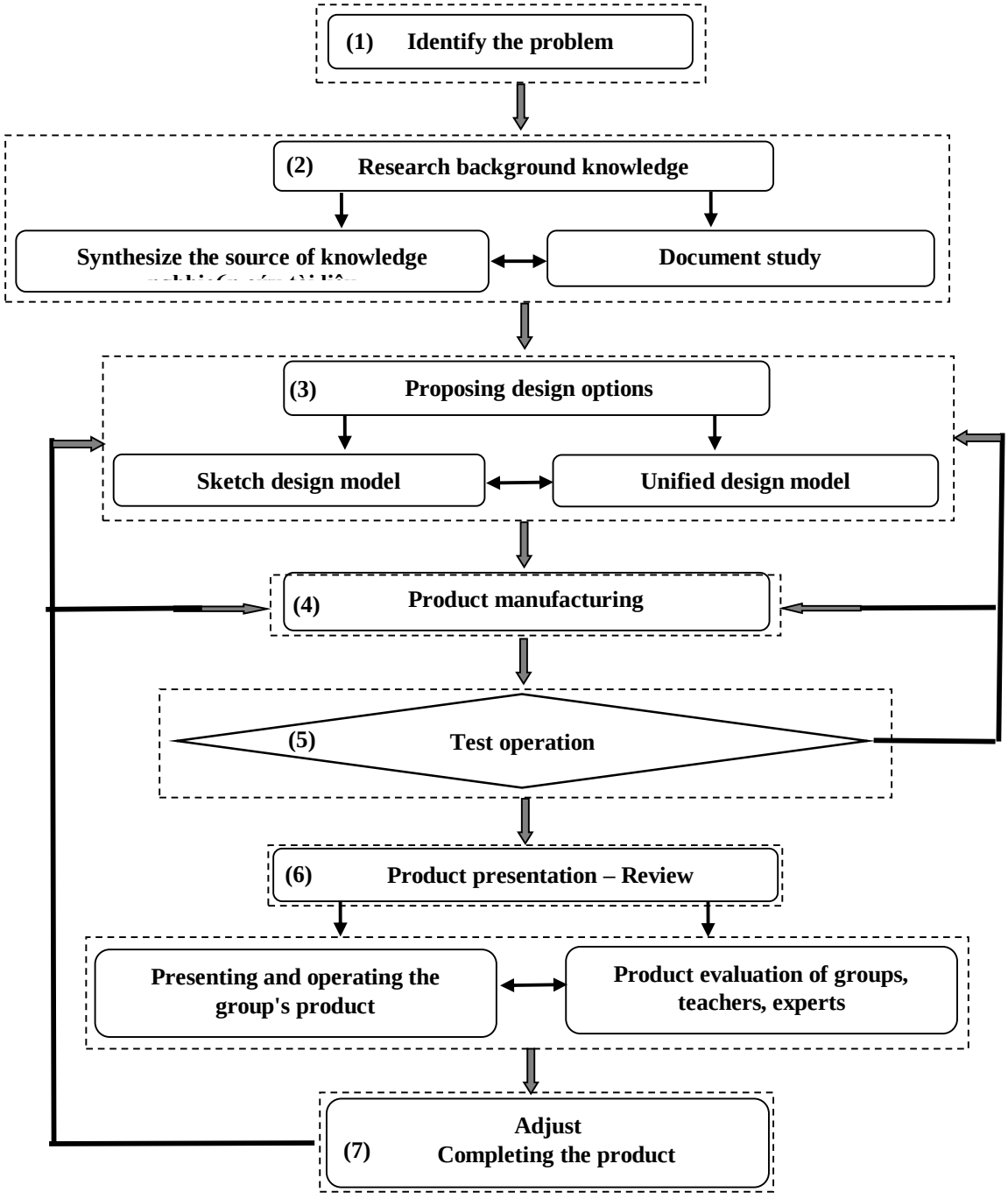
When Christmas and New Year's Eve are around, you should design and create a decorative light circuit for your home.?

Lesson oriented questions:

- What components and equipment are used to create decorative lights?
- Why is power source needed? What is power source? What types of power sources are there? What scientific principles does each type of activity rely on? What kind of power source uses green energy (environmentally friendly)? What kind of power supply can you make yourself to light up some LEDs?
- When do we need to pair the power supply? What does the reading on the power supply tell us?
- What kind of light bulbs should we use if we want colorful lights? What physics principle does LED work on? Why do LED bulbs have different colors when glowing?
- How to make the lights flicker? What flashing ways are there?

Step 6. Design the process of organizing learning activities.

- We organized the iSTEM topic learning activity "Decorative lights" for a group of students according to a 7-step technical design process:



Step 7. Design plans and tools to evaluate learning outcomes according to goals

To evaluate the students' abilities in learning iSTEM topics, we implement an evaluation plan (see Table 7)

Table 7: *Student evaluation plan in teaching iSTEM topic "Decorative lights"*

No.	Evaluation content	Evaluation tool	Max point	Quality Level			
				M1 (Not qualified)	M2 (Qualified)	M3 (Average)	M4 (Good)
NL1	**Problem solving and creativity**	Product evaluation sheet	100	<40	41-60	61-80	81-100
NL2	**Ability to communicate & cooperate**	- Evaluation sheet of product presentation about: + Layout: 5 + Visual: 5 + Language: 5 + Answer and make questions: 10	35	<10	11÷20	21÷25	26÷35
NL3	**Self-study ability**	- Evaluation sheet of product presentation about + Content	50	<20	20÷30	31÷40	41÷50
NL4	**Physical Abilities**	- Evaluation sheet of product presentation: 100 - Evaluation sheet of product presentation about: + Physical basis: 25 + Language: 5 + Answer questions & make questions: 10	140	<50	51÷80	81÷110	111÷140

III. Discussion

The iSTEM topic teaching scenario "Decorative lights" has been pedagogically practiced at Le Hong Phong High School in Ho Chi Minh City, for students in grade 11 who are not majoring in Physics (grade 10 specializing in Information and Science and grade 11 Integration), the period from April 8, 2022 to April 22, 2022 (the project lasts 2 weeks). Here are some pictures of pedagogical experiments.

The 11th graders are art-oriented so we can let them use the Origami paper folding technique to make lights or use recycled products such as straws and plastic cups to make products. Particularly in grade 10, the students are inclined to program on Arduino chips, we can let them program to increase or decrease the brightness of the lights or create various flashing effects.

Figure 2: *The 11th graders are arranging Origami to do the iSTEM topic "Decorative lights"*

Figure 3: *The 10th graders programmed to implement the iSTEM topic "Decorative lights"*

Figure 4: *Students' products after learning the iSTEM topic "Decorative lights"*

Evaluation of student's ability in the experiment of teaching iSTEM topic "Decorative lights"
- Evaluation process and evaluation criteria (see Table 8)

Table 8: *Evaluation Process & Data Processing Specification*

	Group evaluation	**Personal evaluation**	**Teacher evaluation**	**Score**
Step 1	Group score = (personal average + 2 x Teacher score)/3	Group score = average Personal score	Coefficient 2	
Step 2	Personal evaluate (Personal score = Group score ± 5)	- Personal evaluate (students in group rate each other) + Active and hardworking + Average + Slow	Group score + 5 Group score + 0 Group score - 5	
Step 3	Analyzing data	- Make a list of students to research (randomly select 4 groups, each group select 3 students from 3 subjects in Step 2). - Score each student's ability according to table 5 - Scoring on Ability level		

Results of the evaluation of students' ability in the case study through the experimental teaching of the topic "Decorative lights" (see Table 9)

Table 9: *Evaluation of students' ability in teaching the topic "Decorative lights"*

Student group	**Student's name (Encode)**	**NL1**	**NL2**	**NL3**	**NL4**
N1	N1.1 (G)	M3	M4	M3	M3
	N1.2 (K)	M2	M3	M2	M3

Nn.m

(n) The first index is student group

(m) The second index is student

m=1 Excellent student

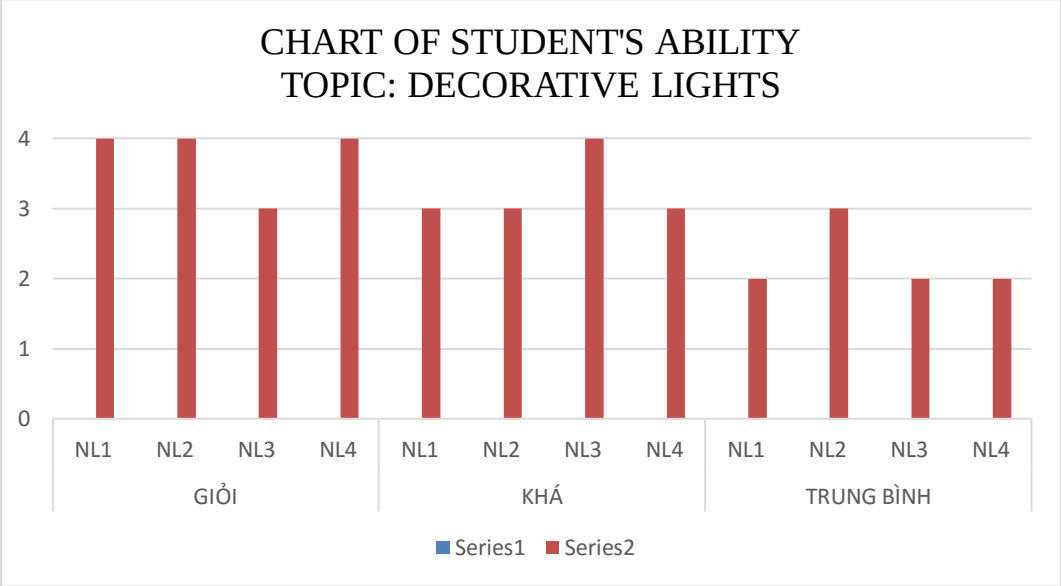
	N1.3 (TB)	M2	M3	M2	M2	m=2 Good student
N2	N2.1	M4	M4	M3	M4	m=3 Average student
	N2.2	M3	M4	M3	M3	
	N2.3	M3	M4	M3	M3	
N3	N3.1	M3	M4	M4	M3	
	N3.2	M3	M3	M4	M3	
	N3.3	M2	M2	M3	M2	
N4	N4.1	M3	M3	M4	M3	
	N4.2	M2	M2	M3	M3	
	N4.3	M2	M3	M2	M2	

Table 9 clearly shows the ability levels of each student in the group studied through the topic “Decorative lights”. We have determined the students' ability levels from the evaluation of knowledge and practical products presented and reported by students. From the teacher's score board combined with the group's evaluation of each subject's learning process, the group's score and personal evaluation, we evaluate the student's ability levels.

In order to have a general evaluation of the student's ability in the study area, we make Table 10 and a chart showing the students' ability levels (see Table 10).

Table 10: *Results of evaluation of students' ability in the research area during and after teaching the topic “Decorative lights “*

Student ability type NL i.j	**Level of achievement**				**Note**
	M1 (none)	**M2 (Qualified)**	**M3 (Good)**	**M4 (Excellent)**	
NL1.1				x	**NL i.j** With **i** encode the ability type (i = 1,2,3,4) i = 1 Problem solving & creativity i = 2 Communication ability i = 3 Self-study ability i = 4 Physic ability With **j** encode student (j = 1,2,3) j = 1 Excellent student j = 2 Good student j = 3 Average student
NL2.1				x	
NL3.1			x		
NL4.1				x	
NL1.2			x		
NL2.2			x		
NL3.2				x	
NL4.2			x		
NL1.3		x			
NL2.3			x		
NL3.3		x			
NL4.3		x			



Based on Table 10 and the chart showing the ability level, we evaluate that the Excellent, Good, and Average students in the research area have positive development of problem solving ability, communication ability, self-study ability and physical ability compared to before implementing the topic.

The development of the abilities of the students in Tables 9 and 10 will be further studied through experimental teaching of level 2 and 3 iSTEM topics.

In the experimental teaching topic, we evaluated 4 students' abilities according to the criteria in the Rubic evaluation table at levels from 1 to 4.

For the ability of solving problems and creativity, we evaluate through the scores achieved by students in 6 standards of practical products to determine the level of competence achieved. The remaining abilities include Communication and Cooperation; Physics ability; Self-study ability. We evaluate the level of ability through a combination of products standards and we find that students make progress after implementing the topic.

IV. Conclusion

Level 1 iSTEM topics integrate knowledge and skills of a natural science subject with Technology, Informatics and Math subjects to solve practical problems that bring real value to life.

The theme of Decorative Lights integrates knowledge and skills of grade 11 physics (Semiconductor, Power Source, Circuit, Ohm's Law) with knowledge and skills in Informatics (Arduino programming), Technology subject (types of LEDs, rectification of currents, skills in using electrical tools, assembling circuits, welding, ...), Math (calculating circuit parameters, measuring, drawing pictures, ...).

Six criteria and seven-step process of designing and organizing iSTEM topic were applied to build the topic. In which the product specification sheet, product evaluation sheet, presentation evaluation sheet, student ability evaluation plan are our creative proposals, which can be applied to the development of plans and projects evaluation tool in teaching other iSTEM topics - a very difficult problem has now been solved.

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