Application of Information Technology in Research & Development of AIoT Energy Curriculum

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Abstract. The purpose of promoting green energy in various countries is to replace traditional hydroelectric or thermal power generation, especially nuclear power, which is a safety concern. However, in exploring the application of green energy, special attention should be paid to not only saving energy, but also inspiring students' recognition of green energy with application of information technology. In addition, the curriculum is designed to provide students with cognitive, technical, and emotional exploration and practical work. This is in line with the spirit of the new curriculum: self-initiative, interaction and mutual benefit. The scale of power generation and energy saving statistics of the solar panels installed in the school are 55,000 kWh of electricity generated per year. The team received a grant from the Sustainable Energy Program (2022) to implement a new syllabus that combines programming and circuit board implementation, and includes modules for the Internet of Things. The faculty community developed a lesson plan to develop an IoT intelligent energy saving c curriculum, which allows students to program power saving switches and develop cross-domain key capabilities to demonstrate smart control via the Internet of Things and APP.

Keywords: Artificial Intelligence · Internet of Things · Green Energy Curriculum

1 Introduction

In response to YMHS receiving the Sustainable Energy subsidy Program (2022), combined with past AIoT experience [1], the curriculum development is based on artificial intelligence Internet of Things (AIoT). IOT is the Internet, traditional telecommunications networks and other information bearing A body, allowing all ordinary objects that can perform independent functions to realize an interconnected network. Smart energy

X. Yuan et al. (Eds.): ICEKIM 2023, AHCS 13, pp. 1653–1664, 2023.
https://doi.org/10.2991/978-94-6463-172-2_183

saving is based on innovative teaching modes such as the Internet of Things, APP design, programming design, etc. and the auxiliary application of technology to cultivate students' multiple abilities such as green energy conservation knowledge, dialectical thinking, and sustainable development of SDGs. It is proving that tomorrow is an era that requires bold imagination. It is the era of the Internet of Things where everything will be connected to the Internet. It will become the most important core knowledge, and tomorrow's changes will bring about an industrial revolution. The logic and management methods we used to think and apply in the past may no longer be applicable, but there is a certain track to follow. The author, Dr.Y-F Lin (associate professor), is the host of the project. He received the project subsidy from the Ministry of Education (Taoyuan Education Bureau subsidy scheme) to build a sustainable energy development center in YMHS, and cooperated with National Taiwan University of Science and Technology (a fuel cell field center) cooperation), ChungYuan Christian University (cooperation of smart grid), LungHwa University of Science and Technology (practice course) and National Taiwan Ocean University (cooperation of offshore wind power and marine education) to jointly conduct research.

2 Curriculum Focus on Artificial Intelligence Internet of Things

Based on the development of the YMHS teacher community (marked in the acknowledgment section), the curriculum focuses on the artificial intelligence Internet of Things technology in series with the three axes of "control system [2], smart energy saving, and smart life". Through course teaching, consulting, and promotion, teaching in the experience and practice of learning, create the innovation highlights of smart energy-saving school.

2.1 In the Curriculum Planning Section

Based on the basic literacy and core competencies, as well as the four levels of basic science, practice, reflection and feedback, curriculum planning and design are carried out, and the longitudinal relationship among the three elements of educational objectives, core competencies and curriculum planning is designed as curriculum (learning) objectives, as a reference for students to take multiple elective courses.

2.2 In the Teacher Teaching Section

The design of the teaching syllabus for the teacher community should first determine the basic literacy and core abilities that the curriculum can achieve, and then design the teaching objectives and teaching content accordingly. At the same time, the evaluation of students' learning should also be based on basic literacy and core competencies and make rolling corrections. Finally, in order to improve the quality of teacher-student interaction, the team makes good use of teaching technology and establishes a digital teaching model as a channel for two-way interaction between teachers and students.

2.3 In the Learning Resources Section

Under the coordinated planning of teachers, professors and professional resources, provide the necessary manpower (teachers and administrators), material resources (soft and hardware equipment), financial resources (teaching and learning funds), and space (professional technology classrooms) to enable students Have a high-quality IoT learning environment.

2.4 In the Student Learning Section

Construct a complete package through the subsidy program, including comprehensive training, independent learning, industry-university cooperation, and the establishment of key capabilities for inquiry, which meet the information security capabilities required in the program.

2.5 In Education Training and Promotion

With the guidance of professional lecturers at the school, the use of the Internet of Things and programming language software guides children to the world of logical thinking and triggers their curiosity about unknown fields. Then the lecturers play an auxiliary role to cultivate students' professional talents.

2.6 In the Part of Education Evaluation and Consultation

Through the consultation and counselling meetings of the master plan (Fig. 1) or the organization of study activities, we increase the teachers' ability to improve themselves, to raise their dilemmas and improve their deficiencies, and to develop new curricula with multiple elective courses through rolling revisions, so that learning is no longer a burden but a pleasure.

2.7 Participation in the Competition and Presentation of Papers

Under the leadership of the author, the project is an industry-academic cooperation program. Under the guidance of professors, teachers and practitioners, university and secondary school students demonstrate the effectiveness of smart energy conservation in various fields. Through a competition organized by the Shayang-Ye cultural and educational foundation, students are able to enhance their practical and information core skills. The author led a group of teachers to publish papers in international journals in the first and second years of the AIOT curriculum and the investigation of power saving in solar power generation.

Fig. 1. The general plan is that Dr.Lin (@NKNU), Dr.Chang and Mr.Yan visited the school, explained by the host, and the team received consultation and counselled on the plan in 2022.

3 Development and Innovation Achievements in IT Applications

Implementation steps of curriculum based on teacher community and co-development (Fig. 2).

3.1 AIoT Intelligent Energy-Saving Switch as a Learning Target

a. Improve the basic concept of energy through the Wi-Fi Internet of Things control panel, and develop the thinking, habits and attitudes of energy conservation.
b. Learn to use the open source hardware Wi-Fi IoT control board for interactive design.
c. Learn to use the Wi-Fi Internet of Things control board to design the control of LED, RGB LED, relays, and environmental sensing components.
d. Learn to use the Wi-Fi Internet of Things control board to connect to the Wi-Fi network.
e. Learn to use the Wi-Fi IoT control board to sense and integrate the Thingspeak cloud IoT platform.
f. Learn to use App Inventor II to make your own mobile app, and use mobile devices to conduct IoT sensing and interactive control.

Fig. 2. Teacher professional development in professional learning community for sustainable energy education.

g. Cultivate independent learning ability, learn self-training to become a maker (To be a maker). Prerequisites: Physics-courses in electricity and electronic circuits and programming concepts.

3.2 Integration of Energy Education Issues (the Brackets Are the Corresponding Indicators of the Curriculum)

a. Learning theme: energy awareness, energy concept and action participation.
b. The substantive connotation of integration
   (a) Energy awareness (energy U2): understand the importance of improving energy use efficiency.
   (b) Energy concept (energy U3): understand the meaning of efficient use of energy.
   (c) Action participation (energy U8): use knowledge, collect data, and use creativity to make physical works related to energy conservation.

3.3 Adapting to the Application of Information Technology in the New Curriculum Syllabus

a. Learning Performance in IT Applications

(a) (operation t-V-2) can use programming to realize the problem-solving method of computational thinking.
(b) (Operation p-V-1) Can integrate information technology to communicate effectively.
(c) (Science pe-Va-2) Be able to correctly and safely operate items, equipment, technological equipment and resources suitable for the learning stage (Fig. 3). If necessary, technological interfaces and platforms can be used to assist in recording (Fig. 4).

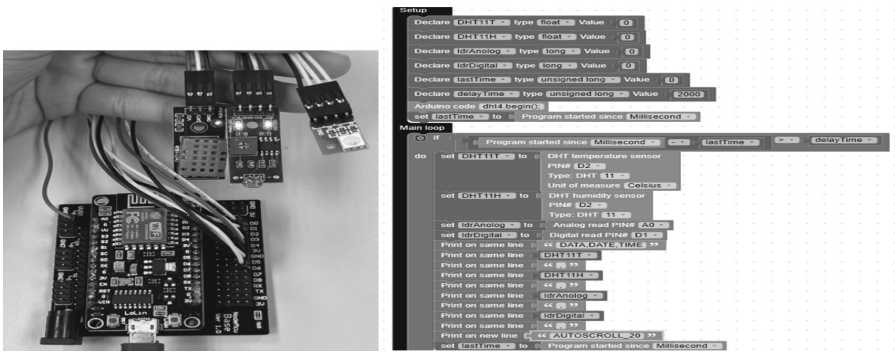

Fig. 3. Photosensitive module device (left) and operation with building block program (right).

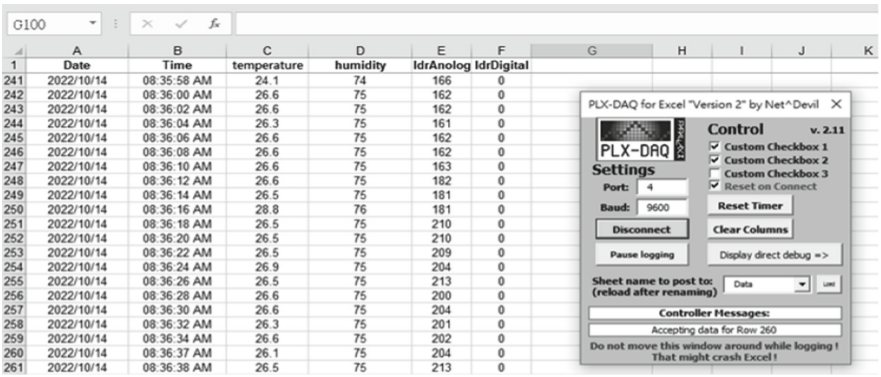

Fig. 4. Photosensitive module control, temperature control, humidity control, and serial EXCEL (within PLX-DAQ).

b. Learning Content.

(a) (Science PMc-Vc-2) the application of electricity in daily life.
(b) (Information T-V-1) The concept and tool use of digital co-creation [2–4].

3.4 Correspondence with the New Curriculum Outline

a. In teacher teaching and student learning: from photosensitive module control and parameter detection, to temperature and humidity module control and parameter detection, supplemented by building block programs, and finally connected to computer EXCEL to draw data (Fig. 5).
b. Supplemented by photosensitive analogy Parameter adjustment and switch status adjustment (remote control) achieve intelligent control and transmit Thingspeak IoT (Fig. 6).

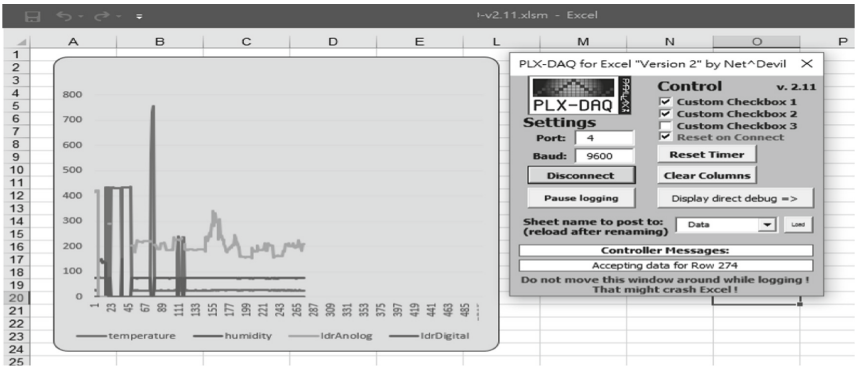

Fig. 5. Obtain temperature, humidity, analogy photosensitive and digital photosensitive mapping based on the above values (within PLX-DAQ)

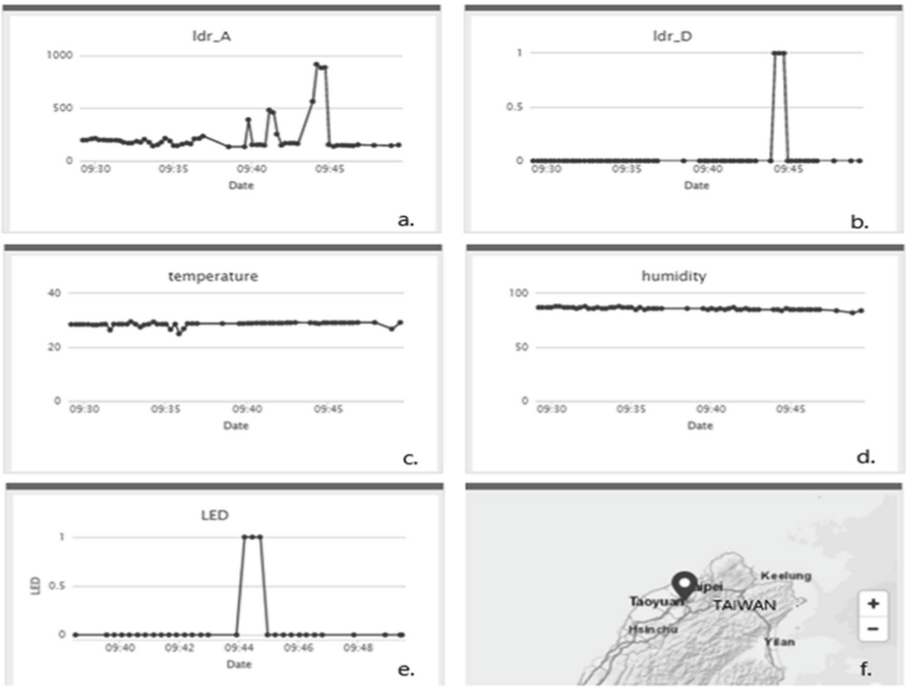

Fig. 6. Status upload of photo-resistor and DHT temperature and humidity sensing within Thingspeak IoT (from fig a. to fig f.).

c. Conduct accurate and efficient qualitative observation or numerical measurement. Completion of AIoT smart energy saving (Fig. 7) [2–4].

4 Innovations and Achievements

4.1 Achievements of AIoT Innovation Curriculum

The final development schedule and content of the AIoT curriculum development: curriculum and energy overview, IoT sensing layer and network layer implementation, cloud IoT platform Thingspeak integration application-IoT smart switch monitoring, cloud IoT platform Thingspeak integration application -IoT smart switch monitoring, discussion on the application of smart switch life energy saving (group discussion, planning, report). The curriculum will be revised on a rolling basis. From the second half of 2021, it will be developed, taught, revised, and assisted by problem-oriented formation of multiple AIoT intelligence connotations. It really fits PBL and is learner-centered (see below for the definition of PBL by the Energy Education Center, https://learnenergy.tw/), in the process of citing real problems to trigger discussions, and guided by the teacher's questions, students can develop critical thinking and problem-solving skills.

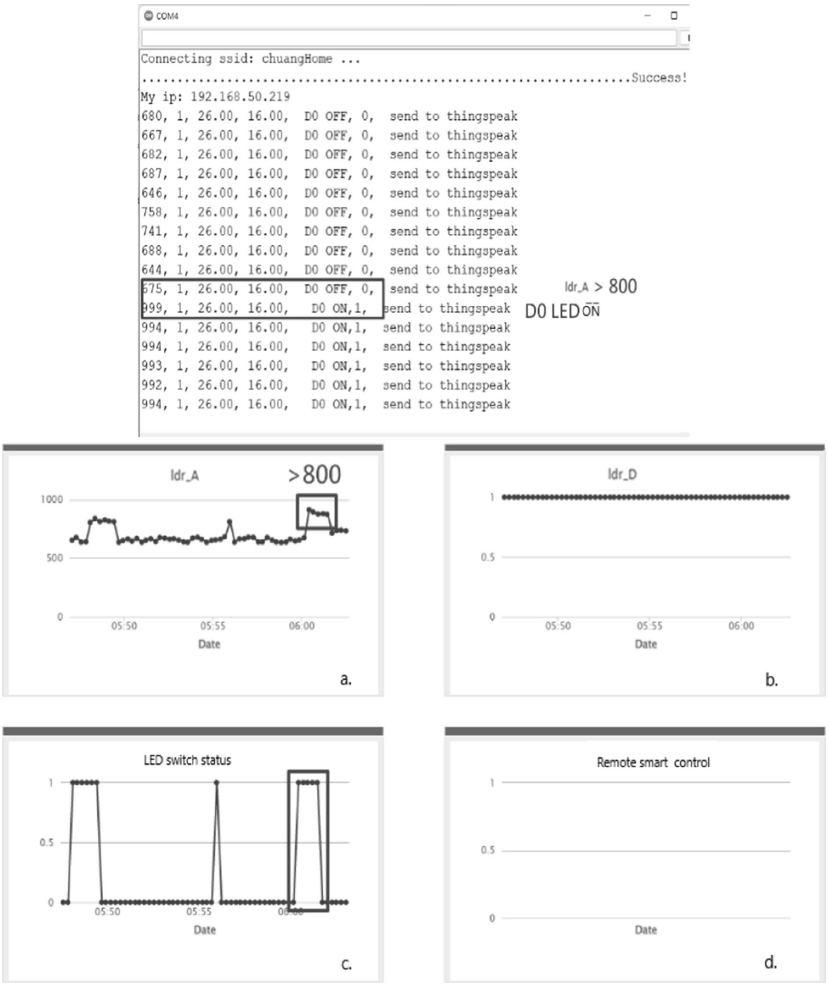

Fig. 7. Supplemented by the parameter adjustment of photosensitive analogy (left), plus the adjustment of the switch state (remote control) to achieve intelligent control and transmit Thingspeak IoT. Perform precise and efficient numerical measurements. Completion of AIoT smart energy saving (right fig a. to fig d.).

This curriculum allows students to discuss in groups, discuss the initial solution to the problem, and evaluate its feasibility, then analyse and explore the impact of subsequent extensions, and finally make a substantive presentation. The whole set of research and development courses has been extended from 12 weeks to 16 weeks. In the future, it will be supplemented with formative assessments and summative reports, and will develop into multiple elective courses for schools (Table 1).

Table 1. Already developed AIoT curriculum content.

Number of teaching weeks	Teaching activities	Content of Curriculum activities (within Courses)
1–2	Curriculum and Energy Overview	Introduction to the curriculum description, introduction to energy, understanding of the IoT architecture, IoT applications
3–4	ESP8266 Wi-Fi IoT Control Board Introduction	1. Build the IoT development environment: 1.1 Arduino IDE, download and install 1.2 Control board USB chip driver download and install, 1.3 Add Arduino IDE to support ESP8266 control board 2. Basic introduction to the IoT development board [2]: 2.1 Introduction to the use of GPIO on the ESP8266 control board, 2.2 Introduction to the use of I/O expansion board pins 3. Circuit assembly of IoT development board and external components: 3.1 RGB LED circuit assembly 4. Hands-on implementation: built-in LED, external RGB LED blinking: 4.1 RGB LED digital output control program design. 4.2 Program upload control board execution. 4.3 Serial port window use. 4.4 Observe RGB LED digital output action. 4.5 RGB LED digital output control. 4.6 RGB LED analogy output control
5–6	IoT sensing layer and network layer work	I. Environmental sensor control 1. Light sensor control:1.1 Light sensor and control board circuit assembly.1.2 Design program to control the light sensor element to obtain the light sensor value.1.3 Serial port window to monitor the light sensor value.1.4 Execute EXCEL program to receive serial port data using extensions and import photoreceptor values into EXCEL worksheet.1.5 Create a monitoring curve of the light sensor value over time 2. Add temperature and humidity sensor control:2.1 Temperature and humidity sensor and control board circuit assembly.2.2 Install the DHT11 program library.2.3Design the program to control the light sensor and the temperature and humidity sensor at the same time to obtain the light sensor value and the temperature and humidity sensor value.2.4 Monitor the light sensor value and temperature and humidity sensor value by serial port window.2.5 Execute the EXCEL program, use the expansion to receive serial port data, and import the light sensor value and temperature and humidity sensor value into the EXCEL worksheet.2.6Produce the monitoring curve of light sensor value and temperature and humidity sensor value over time. II. The intelligent switch implementation and control: 3. Intelligent switch operation and relay control:3.1 Smart switch circuit introduction.3.2 relay module function introduction 3.3 Smart switch and control board circuit assembly.3.4 Use commercially available light bulbs, cell phone charging as the smart switch load to understand the smart switch action 3.5 Design program to control the smart switch action, monitor the smart switch status. 3.6 Serial port window to monitor the smart switch action status. 4. Environmental sensor and intelligent switch interactive control: 4.1Light sensor, temperature and humidity sensor, smart switch and control board circuit assembly.4.2Design program for interactive control of environmental sensors and smart switches4.3Monitor light sensor value, temperature and humidity sensor value, and smart switch operation status by serial port window.4.4Execute EXCEL program to receive serial port data using expansion, and import light sensor value, temperature and humidity sensor value, and smart switch operation status into EXCEL worksheet.4.5 Create the monitoring curve of light sensor value, temperature and humidity sensor value, and smart switch operation status. 5.IoT network layer implementation within Wi-Fi connection: Control board and Wi-Fi connection control.5.1Design the program to connect the control panel to Wi-Fi.5.2 Monitor the status of control panel and Wi-Fi connection by serial port window.

(*continued*)

Table 1. (*continued*)

Number of teaching weeks	Teaching activities	Content of Curriculum activities (within Courses)
8–10	Cloud IoT platform Thingspeak integrated application - IoT Smart switch monitoring	Cloud IoT Platform Thingspeak [5] Integrated Application - IoT Smart Switch Monitoring: 1. IoT Smart Switch (1): Using ThingSpeak IoT platform.1.1ThingSpeak IoT platform registration.1.2Establish the Channel and Fields used to set the receiving sensing value, temperature and humidity sensing value, and see smart switch action status. 2. IoT Smart Switch (2): Circuit Assembly.2.1Assembling light sensing element, temperature and humidity sensing element and control board circuit.2.2 Add load and smart switch circuit 3. IoT smart switch (3): interactive control program design.3.1Install DHT11 library.3.2 Design a program for interactive control of environmental sensing components and smart switches, and transmit light sensing values, temperature and humidity sensing values, and smart switch action status to a specific channel built by the ThingSpeak IoT platform.3.3 Use the serial port window to monitor the light sensing value, temperature and humidity sensing value, the status of the smart switch and the information sent to the ThingSpeak IoT platform 4. IoT Smart Switch (4): Monitoring.4.1 Connect the ThingSpeak IoT platform with a browser to monitor the change curve.4.2 Install the mobile app. View to monitor the change curve. 5. IoT Smart Switch (5): Smart Switch Internet Control.5.1 ThingSpeak IoT platform adds channel and fields for control use.5.2 Design a program to let the smart switch receive the signal action of the ThingSpeak IoT platform.5.3 Control the smart switch across the Internet with a browser.
11–13	Thingspeak and App inventor2 integrated application	Internet smart switch control APP design 1. MIT App Inventor 2 [4] platform login and use 2. Establish an Android emulator test environment 3. Project planning 4. Project screen layout 5. Project programming.5.1 Program design use the mobile APP to send data to the IoT platform ThingSpeak to control the channel and fields used.5.2 Connect the ThingSpeak IoT platform with a browser to test the interaction between the APP and the ThingSpeak platform. 6. Internet smart switch APP interactive control.6.1 Design the control board program to let the smart switch receive the signal action of the ThingSpeak IoT platform.6.2 Use APP to control the smart switch across the Internet.
14–16	Discussion on the application of smart switch life energy saving (group discussion, planning, report)	1. Use courses to learn the relevant skills and structure of Internet smart switches, and explore the application in daily life to achieve the goals of energy saving and convenience. 2. Use creative thinking methods such as thinking checklists, thinking logic methods, and creative matrixes [6] to help students escape their thinking. Through the discussion of the following questions, students are guided to reflect deeply: (1) How can the current architecture be improved? (2) Is there any possibility of regrouping? (3) After the reorganization, what new function does it have? (4) What needs to be reduced or increased for the change? (5) Could the user interface be better? (6) Are there other ways to save energy? 3. Use courses to learn the relevant skills and structure of Internet smart switches, plan your ideas in the above situation, and plan specific methods to achieve your goals, and present them with pictures and texts on A4 paper. 4. Integrate the above-mentioned paper or discussion materials, use the briefing, and go on stage to give a report on energy-saving ideas. 5. Teachers and students will score and give feedback based on creativity, practicality, and energy saving.
ps. Current sensor voltage **reference from** http://eiling.blogspot.com/2019/09/arduino63177-tft-lcdina219.html		

4.2 Curriculum Teaching Weeks, Teaching Activities and Activity Content [2–5]

5 Results

In terms of teaching results and feedback, from the evaluation method of teaching results: the evaluation content and methods of the multi-technology practice course are as follows, and correspond to the connotative indicators of energy issues in the new curriculum [7].

5.1 Implementation Results

The teacher inspects the relevant functions of the smart switch control APP completed by the students to confirm the correctness of the circuit assembly of the control board and the correctness of the sensor and other related functions, and evaluates whether the students can correctly integrate the course content. The assessment method is true assessment (formative assessment). Connotation indicators corresponding to energy issues indicators: U2, U8.

5.2 Issue Discussion Report and Reflection

Through the monitoring data of the APP, discuss relevant issues in the classroom, and complete the report and reflection. Teachers participate in classroom interactions such as classroom feedback and creative thinking, and review student reports and reflections after class to check students' understanding of improving energy efficiency. The assessment methods are file assessment and oral assessment (formative assessment). Connotation indicators corresponding to energy issues indicators: U2, U3.

5.3 Recording and Reflection of Learning History

At the end of each week, students must record their learning history on the collaboration platform and reflect on it. Teachers observe students' classroom performance during class breaks and review student progress after class to confirm students' learning status. A peer review is conducted at the end of the term. The evaluation method is a file evaluation (summary evaluation). Connotation indicators corresponding to energy issues indicators: U2, U3, U8.

6 Conclusion

Furthermore, student feedback and the improvement of the teacher community: After the curriculum is over, use the form and the online co-editing of the teaching platform to collect feedback information from students on the curriculum content and course progress methods, and use it as a reference for subsequent course adjustments and teacher community development curriculum, digital marketing promotion [6] and rolling corrections. Finally, sustainable energy program review: 1. The project is in line with the problem based learning (PBL), practical inquiry and information security areas. 2. Development of multiple elective curriculum in technology [7] (3). Project implementation visit to verify the effectiveness of the program: curriculum development and international paper publication.

Acknowledgments. This research was supported by the Ministry of Education Sustainable Energy Program (Grant TMOE-111(2)- No. 1110060954) & National Defence Discipline Program (Energy & information security) and Consociation of Yang-Ming Educational Affairs Foundation. Thanks to these partners like C-C Chuang (Primary Curriculum Implementer), Y-J Wang, Y-K Lai, M-C Teng, S-Y Lin, and L-F Chen for their efforts in developing and teaching courses, and special appreciate assistance in discussions of professional content from C-H Lin and M-F Lin. Finally, we would also thank the Ministry of Education (including Department of Information Technology, Department of Students Affairs and Special Education),the Education Bureau of Taoyuan Government(Y-K Lai, Chief Secretary), NTUST (Dr. wang, Associate Dean in College of Engineering), NCU (Dr. Hsiau, Dean, in College of Engineering), NOU (Dr. Guan, Associate Dean in College of Engineering), NKNU (Dr. Lin, Director of Industrial Technology Education Department), CYCU (Dr. Hong, Assistant Principal), LHU and Shayangye Cultural & Educational Foundation for their support within strategic alliances.

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