教育部教學實踐研究計畫成果報告

Project Report for MOE Teaching Practice Research Program

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基於設計思考與重視理解的車聯網軟硬體系統與訊號量測的實作課程設計

(Curriculum Development for the Laboratory of In-Vehicle-Networking HW/SW Design and Signal Measurement based on the Concept of Design Thinking and Understanding by Design (UbD))

車用 CAN Bus 網路

(Introduction to Automotive CAN Bus)

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摘要

此門課將針對已經開設兩年的**工學院 x 學程課程--「車用 CAN Bus 網路」**來重新探討實作課程教學方法。新的教學方法開發將基於設計思考(Design Thinking)與 UbD(Understanding By Design) 「重視理解的課程設計」的兩個設計理念來推展，以符合這門跨領域課程的知識範疇與不同基礎的學生背景。

本課程即是將 IDEO 的「設計思考」思維與架構--Understand(了解使用者需求)、Ideate(發展創意概念)、Prototype(設計概念雛型)、Test (評估用戶經驗)，藉由課程的講授、實際的操演，讓學生得以瞭解「設計思考」的精髓，進而運用在實際的教學與生活上，使教學與生活充滿創意、創新，進而達到創意校園的目的。

另一方面，我們會使用到 UbD 的理念來設計課程，也就是根據 UbD 所揭櫫的: 1) 理解(understanding)、2) 大概念(Big Idea)、3) 學習遷移(Learning Transfer)、4)逆向設計(Backward Design) 、5.實作(authentic tasks)表現、6.評量(Assessment)、7.同理心(Empathy)。透過理解過程，讓學生不斷的練習和自我評量，學生將理解的技能和知識作拓展訓練，和生活經驗相連結，從認識自己到能發揮同理心。

關鍵字: 車內網路、控制器區域網路、設計思考、重視理解課程設計

Abstract

This course will revise the teaching method of the hands on course "CAN Bus Network for Vehicles" in the engineering college. The development of the new teaching method will be based on the two design concepts, i.e., Design Thinking and UbD (Understanding By Design) to meet the knowledge categories and different foundations of this interdisciplinary course.

This course employs the IDEO's ``design thinking" guide lines- Understand, Idea, Prototype, and Test. Through the lectures and practical exercises, students can understand the essence of "design thinking", and then apply them to actual teaching and life, making teaching and life full of creativity and innovation, and achieving the purpose of a creative campus.

On the other hand, we will use the concept of UbD to design courses, which is based on what UbD reveals: 1) Understanding, 2) Big Idea, 3) Learning Transfer, 4) Backward Design, 5. Aauthentic tasks, 6. Assessment, and 7. Empathy. Through the process of understanding, students are allowed to practice and self-evaluate continuously. Students will develop understanding skills and knowledge and connect them with life experience, from knowing themselves to being able to empathize.

Keywords: In-Vehicle-Networking (IVN), Controller Area Networking (CAN), Design Thinking, Understanding by Design (UbD)

Research Motivation and Methodology and Outcomes

Vehicles made within the past years are highly dependent on the In-Vehicle-Networking (IVN) technology employed to integrate different sophisticated levels of Electrical Control Units (ECU). For example, the ECUs like electric power steering (EPS), adaptive cruise control (ACC), and anti-lock braking systems (ABS) required the removal of many of the traditional mechanical connections and their replacement with sensors interconnected with Controller-Area-Network (CAN).

Apparently, the auto industry is on a path to provide software-defined vehicles that will greatly improve functionalities that will continue to expand during their lifetimes[1]. Unfortunately, nowadays curriculum for traditional vehicle education is only developed in mechanic engineering (ME) department instead of computer science (CS) or electronic/electrical engineering (EE) department. With the development of the smart car industry, the college students major in automotive engineering are gradually unable to meet the needs of enterprises[2]. The main reason is that the automotive engineering professional talent training system has problems such as old curriculum system, one-sided knowledge system, and insufficient training of students' comprehensive innovation and practical ability. Definitely, global technological colleges have recognized this irreversible trend. Thus, in order to educate the future engineers whom should be able to deal with complex design challenges in a multidisciplinary setting, a new course structure should be developed.

PBL is a well-known and powerful inductive teaching method to support students in becoming creative and innovative thinkers and to develop associated and relevant skills. It is also an educational approach commonly used to foster students' design thinking[3]. In this project, the concepts of "Micro-Cycle" for teacher professional development (PD)[4] and "Cyclical and iterative project-based laboratory"[5] are adopted and transformed during the PBL process for this class. Iterative practice is designed to be incorporated with project based learning process.

In the researcher/teacher class – Automotive In-Vehicle-Networking(IVN), two hand-on project laboratories are developed for students to capture the idea of message frame and understand the protocols of automotive CAN (Controller Area Network) Bus communication standard. Especially, each laboratory will be conducted iteratively *twice* (as shown in Table 1) in different weeks before and after receiving systematic introduction to the knowledge required for laboratory. The main objective for the first conduction (#1) of each project is only to train the students to be a technician with basic skills. The first conduction (#1) focus on wiring, assembly and measurement of electronic modules comprising an analog and digital circuit.

Different to the first conduction of each project which is skill based and fundamental for entry level student. The second conduction (#2) added with supplement lecture material is to construct a more complete knowledge scaffolding for IVN. That is, we will inspire the students with more

creative idea based on the supporting material being taught following up this laboratory.

Table 1 Class schedule arrangement for Automotive In-Vehicle-Networking

	Weeks									
	1-3	4-5	6-7	8-9	10-11	12-13	14	15-16	17	18
Content	Lecture	Lab-1 (#1)	Lecture	Lab-1 (#2)	Lecture	Lab-2 (#1)	Lecture	Lab-2 (#2)	Lecture	Report

In order to highlight the characteristics of vulnerability of a real-world vehicle in the future. The coaching material and designed projects will help our students to understand that modern vehicles transmit information may not be secure, and it is susceptible to be attacked. The Lab-1 named as "CAN Counter" (Figure 1) is designed to help our student understand the fundamental physical layer and data link layer of the OSI standards[6](Figure 2). However, the Lab-2 named as "CAN+IOT" (Figure 3) is designed to let our students experience the cybersecurity threaten based on the layer sense delivered in the Lab-1.

Cybersecurity poses as one of the biggest threats to modern society. Nowadays, if a malicious ECU were to gain access to the network, modern vehicle networks would have little power to stop them. Some of which could be even dangerous and fatal to both car and driver. In the second conduction (#2) of the Lab-2, students are encouraged to propose the solutions for preventing the potential attacks that will exist in the future autonomous vehicles (AVs). Thus students have to develop a microcontroller-based system with a significant effort made in programming(Figure 4). On the other hand, the basic code of engineering ethics is presented for students.

From the Quantitative and qualitative data gathered(Figure 5), we have successfully developed a good coaching practice in PBL. The numeric data in Figure 5 indicates the "week-number of the school year." The less the value is the efficient of the specific evaluation for the questions for students. For example, regarding the evaluation question – "對於老師的教學方法認同", the 110-2 school year students will be reduced from 6.7th week(110-1 school year students) to 6.5th week. Regarding evaluation question – "對於未來的就業方向", the 110-2 school year students will be dramatically reduced from 14.5th week(110-1 school year students) to 9.3th week.

Evidently, through the course, we realize that PBL definitely has the benefits on promoting students to develop critical thinking skills, problem-solving abilities, and communication skills[7]. It can also provide opportunities for working in group and life-long learning and future research. The researcher also perceives the importance of professional development (PD) for teacher. The instructional coaching strongly affects what students learn from PBL (Problem/Project Based Learning) and how they perceive it. Also it positively influenced teachers' self-efficacy[7] to implement project-based learning.

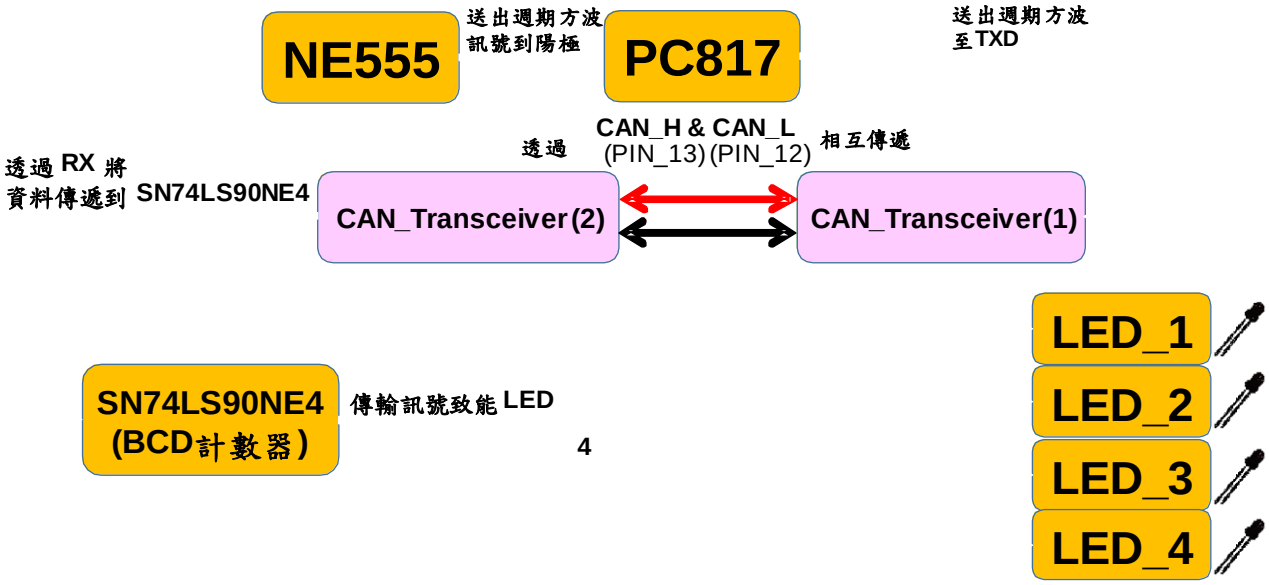


Figure 1 Block Diagram for Lab-1 (CAN Counter)

Figure 2 Student work for Lab-1 (CAN Counter)

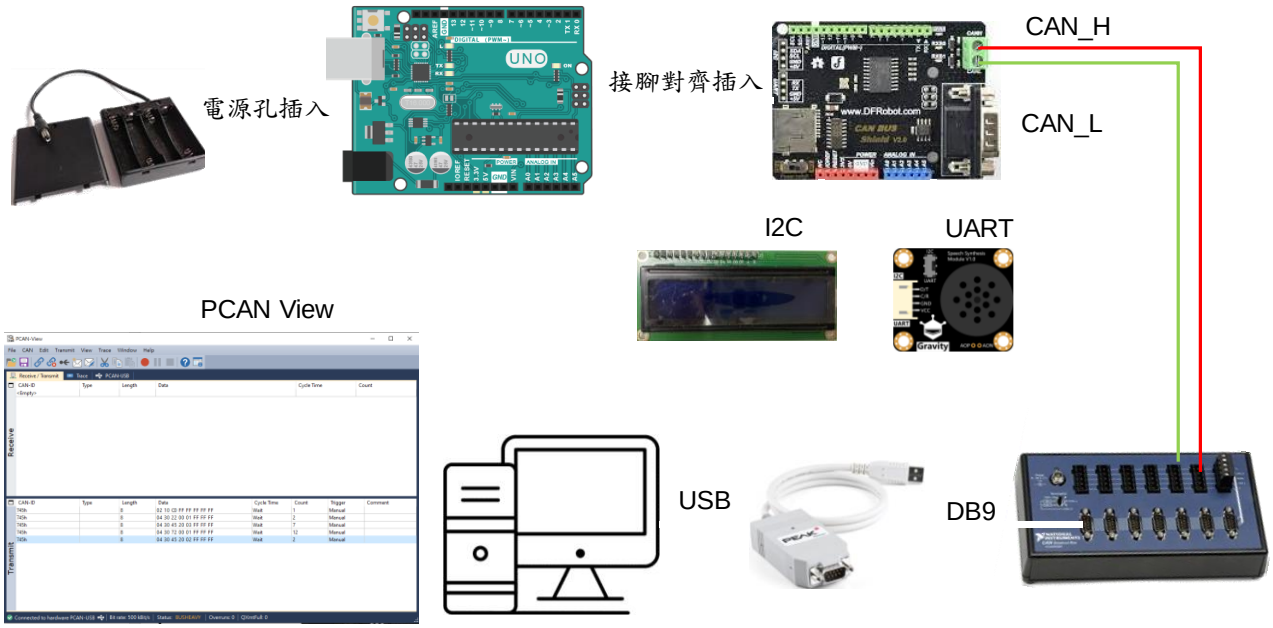
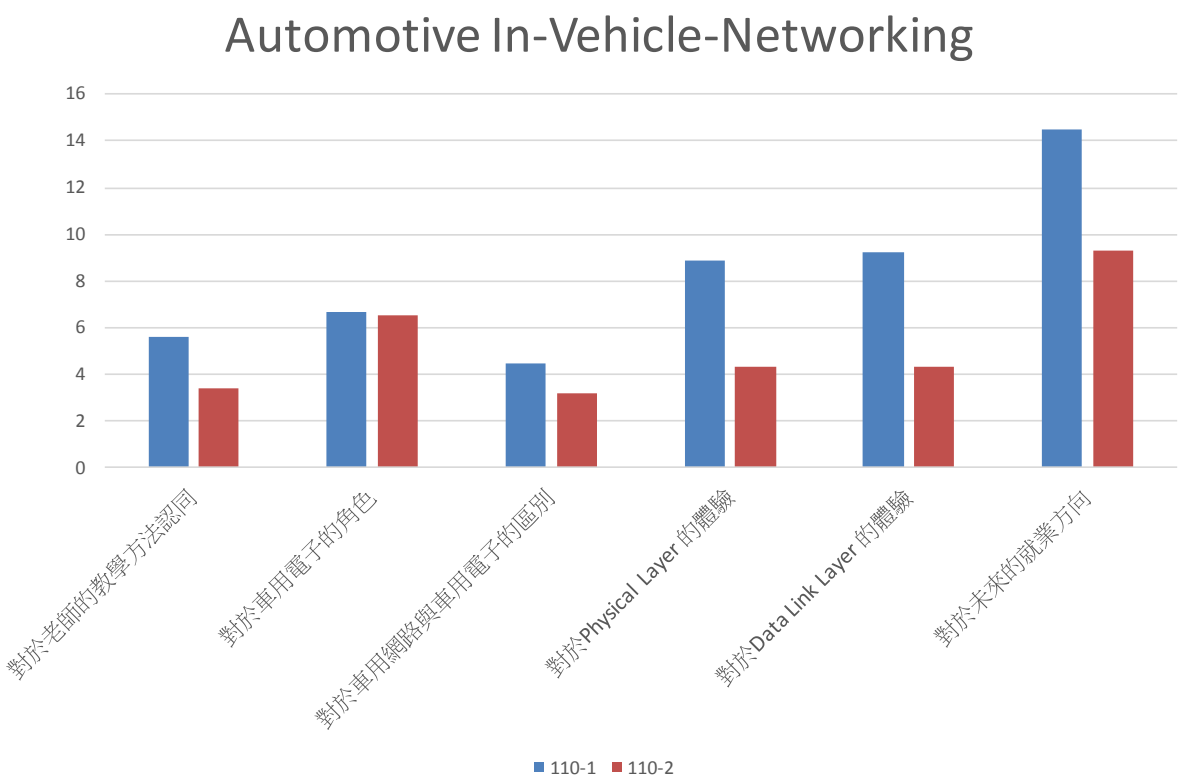


Figure 3 Block Diagram for Lab-2 (CAN+IOT)

Figure 4 Students work for Lab-2 (CAN+IOT)



	對於老師的教學方法認同	對於車用電子的角色	對於車用網路與車用電子的區別	對於 Physical Layer 的體驗	對於 Data Link Layer 的體驗	對於未來的就業方向
110-1	5.6	6.7	4.5	8.9	9.2	14.5
110-2	**3.4**	**6.5**	**3.2**	**4.3**	**4.3**	**9.3**

Figure 5 Statistics results for Students achievement

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