

## The application of the case teaching method to a mechatronics course

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**ABSTRACT:** The case teaching method utilises actual projects for the design of teaching units, for example, for a mechatronics course. Through case teaching, students can acquire problem-solving skills, and develop analytical and creative faculties. Students can identify ways to achieve acceptable outcomes via questions and discussions between students and the teacher. Based on these experiences, students can overcome the learning difficulties associated with other case projects. In this study, the author describes how a teacher uses the case teaching method in a mechatronics course offered by the Department of Industrial Education and Technology at the National Changhua University of Education (NCUE) in Changhua, Taiwan. The teacher explains the case project to the class and mentions several methods that students can apply to tackle the problem, but does not propose a definite outcome. In groups, students design their own project and present their project to the class. In contrast to conventional teaching methods, the case teaching method helps students learn how to think innovatively and develop critical thinking skills for solving problems.

### INTRODUCTION

Learning styles vary among individuals. Some individuals may be very efficient when learning from reading materials only, whereas others require hands-on experience. However, psychological investigations have demonstrated that individuals generally only remember roughly 10% of the read content and 90% when the material is actually experienced. Students typically learn and retain information well when they are engaged with instructional materials. Students generally learn 20% of the material taught via hearing, 40% via seeing and hearing, and 75% via seeing, hearing and doing. Well-designed teaching modules offer the possibility of achieving this 75% goal [1].

It should be mentioned that many engineering educational institutions are progressively introducing Computer-Aided Learning (CAL) packages as an alternative to hands-on practical laboratories. Hands-on practical laboratories, such as case projects, can help students understand and apply theoretical knowledge in practice [2][3].

Case teaching is an instructional approach that presents situations for analysis and information based on which decisions are made, rather than teaching concepts and theories to students. Learning through case studies occurs when analysing data, by making decisions based on appropriate recommendations and actions, by communicating such decisions and discussing their rationales with fellow students and the teacher, and, most importantly, accepting responsibility for decisions.

Langdell of Harvard University formally introduced the case teaching method and applied the method for teaching law in 1870. Langdell determined that law students learned more from analysing cases than from reading textbooks. Although textbooks allowed students to memorise laws, Langdell wanted students to learn how to apply laws to different situations [4].

Although the case method has been utilised for years to teach law, business and medicine, it is uncommon in the sciences. However, case studies hold great promise as a pedagogical approach for teaching the sciences, particularly to undergraduates, because it humanises science and effectively illustrates scientific methodology and values. The case teaching method develops students' skills in group learning, speaking and critical thinking. Furthermore, using cases in the classroom makes science relevant [5].

The mechatronics course is a design course that has no definite answers; its goal is to induce students to brainstorm and analyse. Mechatronics projects typically require teamwork and considerable discussion.

### APPLYING THE CASE TEACHING METHOD TO A MECHATRONICS COURSE

The case teaching method is a student-centred education concept and strategy that underscores life experiences. This approach uses real cases as a reference point with the aim of identifying a problem solution. Self-learning is an important component of the case teaching method. Interactive teaching processes of question-answer and discussions between teachers and students, as well as among students, are utilised to assist students in gaining real experiences in attacking a problem, developing problem-solving abilities and creativity.

Van Eynde and Spencer demonstrated that the case method yielded the better retention of learned material by students than the traditional lecture [6]. Parkinson and Ekachai compared student perceptions of learning using a traditional lecture format and the case method; students taught using the case method indicated that they had more opportunities to practice critical thinking and problem solving [7].

Several important factors must be considered when applying the case teaching method in a classroom [8]. Teachers must have the following competences:

- Be familiar with the teaching material;
- Be able to lead an exploration;
- Manage a class;
- Handle negative response and emotions.

Since the particular technical aspects of laboratories are a function of the emphasis given by individual teachers, the guidelines identified in this study focus on general concepts that should be applied to technical content. The case method allows students to practice applying course materials and fulfil project requirements. Students must work in groups of three or four. Case project requirements also include a written proposal, work schedule, written report and presentations.

The first requirement that students must meet is a written proposal. Groups generate their own case project topics. These groups then write a proposal for their case project. The case project requires the construction of a mechanical device, the design and construction of the necessary electronics and sensors, and writing software. The teacher reads each proposal and meets with each group. During these meetings, the teacher can increase or decrease the scope of the projects. The scope of the projects is altered to ensure that all of the projects have the same degree of complexity.

After the case projects have been selected, the groups must submit project schedules. During the mechatronics course, a teacher regularly assesses whether the projects are on schedule. Deviations from the schedule are discussed and schedule changes are noted. Work schedules are an excellent tool for minimising student procrastination.

Along with completed case projects, students must submit a written report. This report is written primarily for a mechatronics audience and helps the teacher assess the level of mechatronics in each case project. These reports are an essential resource for future students.

## DESCRIPTION OF THE CASE PROJECTS

The following are examples of case projects for the case teaching method. They are an automatic following cart, a fully automatic canopy controlling module and an automatic light-sensitive curtain.

### Automatic Following Cart

The aim of this project is the development of a cart that can move automatically. Transportation is an important part in people's lives. Transportation by handcart is not only time-saving but also avoids wasting labour. However, if using a handcart is convenient, the cart still needs someone to set it in action. People cannot carry things that are too heavy for them to bear.

In order to increase transportation efficiency, infrared ray and direct current motor devices are proposed to control and move the cart. This project stabilises the handcart by strengthening the cart's body. User security is provided by a sensor that prevents collisions. Figure 1 shows an example of the automatic following cart.



Figure 1: An example of the automatic following cart.

### Fully Automatic Canopy Controlling Module

The fully automatic canopy controlling module is intended to be an advanced version of the manual canopy and half-automatic canopy by being fully automatic. This project is developed by using a circuit with light and rainwater sensors. This project uses a signal from a sensor-circuit's output. After receiving these signals, it compares the various ones already taken. From these inputs, the single-chip module controls the movements of the automatic canopy.

The automatic canopy is adjusted according to the intensity of illumination by lengthening or shortening it. But if it rains, the circuit of the rainwater-sensor sends a signal to the single-chip, causing all movement to be cancelled with command to stretch the canopy to its longest range. This product can detect and examine the intensity of illumination and rain; moreover, it has the automatic functions of opening and closing. A new canopy need not be bought; only the control module and special-purpose motor need to be added and installed to make it a fully automatic canopy. Figure 2 shows an example of the fully automatic canopy controlling module.



Figure 2: A fully automatic canopy controlling module.

## Automatic Sensitive Curtain

This project uses a single-chip IC, combined with a luminosity sensor to control the timer setting for automatically opening and closing a window curtain. The proposed method allows for manual and automatic curtain control, providing the user with a convenient method to open or close a curtain when the sunshine is too bright or the sky becomes too dark. This unit has manual, automatic timer and wireless control settings. Figure 3 shows an example of the automatic light-sensitive curtain.



Figure 3: An example of the automatic light-sensitive curtain.

## EVALUATION AFTER APPLYING THE CASE TEACHING METHOD

Assessment is utilised to increase standards at universities in terms of teaching, learning and students' achievements. Assessment quality has a marked impact on students' willingness to work hard and encourages teachers to focus on methods to improve attitudes towards the learning of individual students. Assessment occurs continually as judging oneself and others are common practice [9].

Students can make two presentations. The first presentation is required for grading. This presentation focuses on the technical aspects of projects. The optional second presentation is given to a general audience comprised of other group members and students. This is a showcase presentation that allows students to showcase their achievements. These two presentations teach students that a presentation must be tailored to its audience.

This showcase presentation also allows students to take pride in their accomplishments and share what they have learned. The mechatronics course assessment is also concerned with individual and group achievements. The individual assessment component is based on periodic reports and individual homework.

The absence of conventional examinations is due to the nature of the course and the level of material covered. Various group activities are the basis for the group-grading component and have special importance in light of the time allocated.

The mechatronics course was inaugurated in the Department of Industrial Education and Technology at National Changhua University of Education (NCUE), Changhua, Taiwan, in 2006, and had an initial enrolment of 20 students. Table 1 presents the questionnaire and a summary of the student feedback. This table was designed to evaluate the case teaching method adopted in the mechatronics course. Students responded to questionnaire items on a Likert scale, ranging from 1 for *strong disagreement* to 5 for *strong agreement*.

All students successfully completed and demonstrated their case projects. No student failed the course. The final grades obtained by students were above average. It is clear from the responses that most students favoured the case teaching method. Most students also had no difficulty with the overall approach. Students obviously enjoyed the flexibility of working at their convenience.

Respondents agreed with two items related to an evaluation of the case teaching method and teaching the mechatronics course. For time allocation, the average response was 2.7, indicating that respondents felt that the case project was not optimised time-wise. Students were also asked to indicate their level of involvement in the learning process. The average response of 2.8 demonstrates that most thought that the case project was important; however, some components fell short of students' expectations.

## CONCLUSIONS

The following conclusions have been drawn from the work presented here:

- The case teaching method received positive feedback from students;
- Students enjoyed working within this framework, as evidenced by the care and time devoted to the case projects;

Table 1: Questionnaire and average response for student evaluation of the mechatronics course.

Question	Questionnaire	Response Rate
1	The case projects were useful for learning mechatronics	4.1
2	The background information was useful for understanding content	3.9
3	I could follow the guidelines given in a case project without much assistance	3.9
4	The time allocated was sufficient for me to understand the case project objectives	2.7
5	The course was challenging	4.0
6	Material resources were supplied	3.8
7	I feel that I am actively involved in the learning process	2.8
8	The assessments, overall, provided useful feedback on my progress	4.1
9	I am happy with my performance in the mechatronics course	4.0
10	The mechatronics course, overall, was useful and motivating	4.1

- Students could apply what they had learned to real cases;
- Students understood how to collect, filter and apply information;
- Students learned how to communicate and cooperate with others, and to select from different options;
- Students learned how to criticise others and accept criticism from others;
- Cases can help teachers equally well, especially when teachers care about how their case projects impact on students;
- The overall student satisfaction with learning activities was high.

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