An industry oriented course development for the Master of Engineering

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Structured Abstract

BACKGROUND
With traditional teaching methodologies in educational environments, the Master of Engineering is a research degree requiring completion of coursework and a thesis. The courses based on the knowledge required for the discipline usually follow on from this. The problem with this traditional methodology of learning is that there is no close relationship with industry requirements. Industry oriented education is an approach to learning from an industry perspective. The industry oriented teaching and learning enables a Bachelor of Design graduate to entry this technology oriented Master of Design program.

PURPOSE
The aim of the course development is to build the Master of Engineering student profile in the implementation of industry oriented teaching and learning as an alternative to the current method used of theoretical based.

DESIGN/METHOD
The course Design and Practice of Electric Vehicles was designed and delivered at National Taiwan University of Science and Technology. This short term course is completed in two weeks, with 9 hours of lecturing each week. The teaching plan breaks into 6 parts and each part has 3 hour lectures. The assessment results have been in a brief summary and it was analysed.

RESULTS
Since the course is an industry oriented and project based, the students from Electronic, Control and mechanical engineering can sit in a class to undertake the design and practice of Electric Vehicles where a multi-discipline research team is available. The assessment results showed that such an industry oriented course improved the industry specific outcomes of the learners.

CONCLUSIONS
We proved that an industry oriented teaching can improve the industry specific outcomes of the learners in the Master of Engineering programme as we believe that students can build their industry oriented research background and multi-discipline research experience and skills within the Master of Engineering program.

KEYWORDS
Industry Oriented Teaching and Learning, Master of Engineering, Project based Learning.

Introduction

With traditional teaching methodologies in educational environments, the Master of Engineering is a research degree requiring completion of coursework and a thesis. The conventional coursework is to build the foundation learning through subject based teaching independently e.g. at Auckland University (2013) an Electrical and Electronic Engineering student, who has not a four year BE (Hons) or equivalent qualification, is required at least 60 points from any of the courses, excluding project courses, listed for the Computer Systems Engineering specialisation in the Master of Engineering Studies schedule. The courses based on the knowledge required for the discipline usually follow on from this. The problem with this traditional methodology of learning is that there is no close relationship with industry requirements.

Industry oriented education (Qi, 2008a) is an approach to learning from an industry perspective. An example of previous research a “bridging” technology course (Qi, 2008b, 2009) designed for the first year students in Master of Design program before they start their projects. The industry oriented teaching and learning enables a Bachelor of Design graduate to entry this technology oriented Master of Design program. This paper presents a course development applied industry oriented teaching and learning strategy to be a bridging the Master of Engineering program to the industry work environment.

This approach can be also applied to a traditional engineering undergraduate program (Qi, 2008a) and an industry oriented and multi-discipline undergraduate degree (Qi & Cannan, 2007a). However, the challenges in implementing the industry oriented course are including that e.g. it requires a change in role for the lecturer. In industry orientated education the lecturers were required to build their industry background. The academic staffs were encouraged to join the student industry projects as supervisors to improve their industry background, while industry staffs were invited to teach as guest or part-time lecturers (Qi & Cannan, 2007b).

With implementing an industry oriented short course for the Master of Engineering, this paper presented a case study to build student’s industry oriented research background and multi-discipline research experience and skills within the Master of Engineering program.

Course Design

Being bridging the Master of Engineering program to the industry work environment, at National Taiwan University of Science and Technology a short course within the Master of Engineering program is developed with industry oriented teaching and learning strategy. In the industry environment, the Master of Engineering student build their profiles in the implementation of industry oriented teaching and learning as an alternative to the current method used of theoretical based.

Since the course is an industry oriented and project based, the students from different departments can sit in a class to undertake the design and practice where a multi-discipline research team is available. The assessment results should show that such an industry oriented course improves the industry specific outcomes of the learners. Therefore, the short course will establish an industry oriented case study as an example, a topic of “Industry Oriented Design - Sustainable standalone house with rain water, solar energy and wind energy” will suit students from architecture, construction, mechanical and electrical engineering.

This paper presents a course title “Design and Practice of Electric Vehicles” which is suitable for mechanical and electrical engineering students.

Currently an international collaborative research and development of the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering is under processing of

engineering prototyping and extending to the commercialization in a “virtual industry” environment which is operated as a local industry.

The research and development of the electric vehicles is operated internationally including an industrial design/product design group, mechanical engineering design group, auto electrical design group, electronic and computer engineering group. The students can join in the group relevant to their major however they are encouraged to enrol to this short term course to build their industry background.

This short course is offering in such an industry environment and can be completed in two weeks, with 9 hours of lecturing each week. The teaching and learning strategy applied the case studies from the research and development of the electric vehicles.

The teaching plan breaks into 6 parts and each part has 3 hour lectures/tutorials as showed in Table 1:

Table 1 teaching plan

Teaching Contents	Assessments
1. History of Electric Vehicles, Comparison of the combustion engine vehicles and Electric Vehicles, Comparison of traditional Electric Vehicles and the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering	A short essay is required in classroom 10%
2. Design Details Part 1 – In-wheel Motors and Steering Motors in the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering	A short essay is required in classroom 10%
3. Design Details Part 2 – Battery Management System in the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering	A short essay is required in classroom 10%
4. Design Details Part 3 – Data Communication in the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering	A short essay is required in classroom 10%
5. Design Details Part 4 – Human-machine Interface in the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering	A short essay is required in classroom 10%
6. Commercialization of the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering	A report is required by end of the course 50%

The assessment consists of 5 assignments in electronic copy and required submission by the next class (10% mark/each assignment) and a final report (50%) in electronic copy and required submission by next day of the last class. The total mark is 100% and the pass grade is 50%.

Assessment 1 (10% mark)

The report should be brief and concise (250-300 words) including

1. History of Electric Vehicles,
2. Comparison of the combustion engine vehicles and Electric Vehicles,
3. Comparison of traditional Electric Vehicles and the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering

Assessment 2 (10% mark)

The report should be brief and concise (250-300 words) including

1. A review of in-wheel motors and steering motors in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering
2. The design of integrated wheel system with in-wheel-motor drive and independent steering

Assessment 3 (10% mark)

The report should be brief and concise (250-300 words) including

1. A review of battery management system (BMS) in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering
2. Your recommendation of a suitable BMS to a further development

Assessment 4 (10% mark)

1. The report should be brief and concise (250-300 words) including a review of data communication in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering
2. Your recommendation of a suitable data communication protocol to a further development

Assessment 5 (10% mark)

The report should be brief and concise (250-300 words) including

1. A review of Human-machine Interface in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering
2. Your recommendation of a suitable design for a steering unit including a speed control to a further development

Assessment 6 (50% mark)

The report should be brief and concise (Max 1500 words) including

1. history of Electric Vehicles,
2. comparison of the combustion engine vehicles and Electric Vehicles,
3. comparison of traditional Electric Vehicles and the Electric Vehicles with a Four In-wheel-motor Drive and All-wheel Independent Steering
4. a review of in-wheel motors and steering motors in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering and the design of integrated wheel system with in-wheel-motor drive and independent steering
5. a review of battery management system (BMS) in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering
6. a review of data communication in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering
7. a review of Human-machine Interface in the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering

8. after a view of an existing design of the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering, please present the summary of your recommendation to build a new electric vehicles with a four in-wheel-motor drive and all-wheel independent steering with an integrated wheel system, a suitable BMS, a suitable data communication protocol, a steering unit.
9. a conclusion of the commercialization of the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering

Data Analysis and Discussion

Assessment results analysis

The assessment consists of 5 assignments in electronic copy and required submission by the next class (10% mark/each assignment) and a final report (50%) in electronic copy and required submission by next day of the last class. The total mark is 100% and the pass grade is 50%. The summary of the results were recorded as Table 2.

Table 2 Assessment results

	Assess-ment 1	**Asses-ment 2**	**Assess-ment 3**	**Assess-ment 4**	**Assess-ment 5**	**Assess-ment 6**	**Final**
Average markings	86%	84%	74%	88%	89%	88%	86.3%
Resubmissions	60%	20%	0	0	0	0	-
weighting	10%	10%	10%	10%	10%	50%	100%

As showed in Table 2, the results of the assignments show that the average markings for Assignment 1-6 were between 74%-89% and the final was 86.3%. Some assignments were resubmitted due to unsatisfied quality at previous submissions. There were 60% of the resubmissions in the assessment 1, 20% resubmissions in assessment 2 and assessment 3. It is indicated that the students were quickly settled in the designed industry environment.

From the assignment 1 – 5, students were not only confirming what they learnt from the industry oriented teaching environment, but also starting the design thinking by e.g.

- recommendation of a suitable BMS to a further development

- recommendation of a suitable data communication protocol to a further development
- recommendation of a suitable design for a steering unit including a speed control to a further development

After a review of an existing design of the electric vehicles with a four in-wheel-motor drive and all-wheel independent steering, the students presented the summary of their recommendation to build a new electric vehicles with a four in-wheel-motor drive and all-wheel independent steering with an integrated wheel system, a suitable BMS, a suitable data communication protocol, a steering unit.

The students were also able to propose a commercialization of the electric vehicles and discussions on some key points for further research and development e.g.

“If the wheel broken on the road, what should we do? If there’s only a rear wheel broken, we can let the fault wheel turn to zero degree automatically and so does another rear wheel, thus the car has a front steering. If the front wheel broken, then we the car has a rear steering. The worst situation is that if the three of the wheel are broken, maybe we can add another mechanical control between the working wheel and the broken wheel. Or maybe we can add an additional wheel at the middle of the car just like the airplane. We use it only in emergency (when three or four wheels are broken). At normal operation the additional wheel will hided in the car though I note that it can cause a lot of extra quality and mechanical problems.”

Course evaluation

The National Taiwan University of Science and Technology course evaluation indicated this short course received 4.92/5.00 which a full score of satisfactions is 5.00. The average score of elective courses for the postgraduate programs in the department was 4.50.

The students appraise that “this course is inspiring” and left comments as:

“Although there's not much time for further details, it did inspire me a lot more new ideas.”

“I learn a lot from this class even in only one week. Thank you!”

“Thanks you for teaching us for a few days, but let me understand the latest electric vehicle structure and technique also understand the EV is difficulty to promote to the market, but I believe the EV will become very popular in the future.”

Conclusions

We proved that an industry oriented teaching can improve the industry specific outcomes of the learners in the Master of Engineering programme as we believe that students can build their industry oriented research background and multi-discipline research experience and skills within the Master of Engineering program.

Further research is expected as the challenges in implementing such a short course are that the course development must catch up the cutting edge technology in the current industry and the teaching staff members have to be industry background ready. Meanwhile, a case study is often not only including engineering questions but also the wider engineering education environment e.g. project management and market development.

References

Auckland University (2013). 2013 The University of Auckland Faculty of Engineering Postgraduate Handbook. Retrieved August 14, 2014, from https://cdn.auckland.ac.nz/assets/engineering/for/documents/pg-handbook-2013.pdf

Qi, T. Z. (2008a). Industry Oriented Teaching and Learning strategies applied to the course within traditional engineering technology undergraduate program. Paper presented at the Frontiers in Education Conference, 2008. FIE 2008.

Qi, T. Z. (2009). Work in progress - a course design for a Master of Design program linked to the electronic and computer engineering graduates. Paper presented at the Frontiers in Education Conference, 2009. FIE 2009.

Qi, T. Z. (2008b). Work in progress - a Master of Design program collaborating with Electronic engineering and technology. Paper presented at the Frontiers in Education Conference, 2008. FIE 2008.

Qi, Z., & Cannan, J. (2007a) An Industrial Oriented and multi-discipline undergraduate degree, in The 15th World Conference on Cooperative Education, 26 June-29 June, Singapore.

Qi, Z., & Cannan, J. (2007b). The Changing role of the Lecturer in Industry Orientated Education, Tenth Annual NZACE Conference. Rotorua, 19 April-20 April, Rotorua, New Zealand.

Acknowledgements

The course development and course delivery was full funded by National Taiwan University of Science and Technology.

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