

Integrated coastal zone management education using an industry affiliates programme

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ABSTRACT: Effective coastal zone management requires an educated community with an understanding of the implication of their actions. One particular group that requires guided education includes engineers, who are responsible for suggesting, designing, implementing, managing and monitoring many schemes within coastal zones. While engineers are required to undergo continual training throughout their professional careers, a suitable starting point for focused integrated coastal management training can be identified during their undergraduate years. Through a carefully designed industry affiliates programme, coastal orientated educational activities can lead to enhanced learning through a combination of practical interactions and academic pursuits in coastal engineering and management. Student surveys show that the programme is an effective learning tool that warrants consideration within any engineering degree.

INTRODUCTION

Successful Integrated Coastal Zone Management (ICZM) requires an educated community with an understanding of the implications of their choices, decisions and actions when dealing with coastal zone related management issues and activities. One particular group that needs guided education covers engineering professionals, who are often responsible for suggesting, designing, implementing and monitoring many management schemes and construction works within coastal zones. Traditionally, civil engineers have been responsible for these activities; however, the *new* profession of coastal engineering is now becoming influential as it focuses more on the coastal region rather than the broader areas associated with traditional civil engineering.

A major question that needs to be addressed is how to best educate this new *breed* of coastal engineers. This question arises due to changes in community needs, advancements in educational methodologies, and growing requirements for educators to ensure that their students have the necessary skills to be informed and become effective practitioners.

In this article, the author first outlines what a *coastal engineer* is and does, and how he/she differs from a traditional civil engineer. The author will then examine the industry affiliates programme developed for, and used within, the Bachelor of Engineering in Coastal Engineering programme at Griffith University, Gold Coast, Australia. This programme is used to enhance student knowledge of coastal engineering and, specifically, ICZM issues and practices. This programme places students in the workplace as part of their educational training, with the workplace being any coastal-oriented group whose tasks may include coastal monitoring, policing and management. The author also discusses how, by combining practical interactions with academic pursuits, student learning

could be enhanced beyond that achievable within the standard lecture.

COASTAL ENGINEERING AND EDUCATION

What is a Coastal Engineer?

Coastal engineering is an extension of civil engineering that involves many aspects of civil engineering, but also requires the engineer to have knowledge of nearshore oceanography and marine geology [1]. Additionally, they should have an understanding of wave dynamics (including tsunamis), coastal currents, pollution transport mechanisms, hydrodynamics modelling and wave/structure interactions.

As a consequence of the social and political environment coastal engineer's work within, they must also have a sound understanding of management issues relating to the coastal zone. This includes planning, legislation, ethics and communication. Indeed, the graduate attributes prescribed by the Australian engineering professions accrediting body (as described in Table 1), requires an engineer to be environmentally aware and to have the ability to use a systems approach to problem-solving [2]. Additionally, since a coastal engineer often works on projects where there are no set design rules (unlike many civil engineering tasks, which have set design codes) they must also have the ability to think laterally and draw upon multidisciplinary knowledge (see Table 1).

Examples of typical coastal engineering projects include the design of breakwater systems to defend coastlines, dredging remediation programmes to maintain navigation access, ocean outfall design to dispose of human waste, coastal modelling to predict environment changes, monitoring programmes to see what changes have occurred over time and space, and dune management to ensure sustained aesthetic appeal and coastal

protection. It is, therefore, evident that a coastal engineer requires a broad knowledge and a range of skills that go beyond the more traditional civil engineering base, and that non-traditional education methods may be required to achieve an appropriate undergraduate education. The coastal engineer must also have a sound knowledge of environmental issues – something that can be lacking with a traditional engineering programme, but which is certainly increasing in educational and professional importance, as engineers seek to embrace effective sustainability practices.

Table 1: List of generic attributes (items 1 to 10) required by Engineers Australia for a graduate engineering student (adapted from [2]).

No.	Generic Attributes Required by Engineers Australia from Engineering Graduates
1	The ability to apply knowledge of basic science and engineering fundamentals
2	The ability to communicate effectively, not only with engineers but also with the community at large
3	An in-depth technical competence in at least one engineering discipline
4	The ability to undertake problem identification, formulation and solution
5	The ability to utilise a systems approach to design and operational performance
6	The ability to function effectively as an individual and in multidisciplinary and multicultural teams, with the capacity to be a leader or manager as well as an effective team member
7	An understanding of the social, cultural, global and environmental responsibilities of the professional engineer, and the need for sustainable development
8	An understanding of the principles of sustainable design and development
9	An understanding of professional and ethical responsibilities and commitment to them
10	Expectation of the need to undertake life-long learning, and the capacity to do so
In addition to attributes 1 through 10, two additional ones have been identified for coastal engineering graduates:	
11	The ability to think laterally in finding particular solutions to the diverse complexities encountered by a coastal engineer
12	A multidisciplinary skill set

What is ICZM?

In order to take care of requirements within the coastal zone, a large number of factors need to be considered [3]. These range from natural resource availability, environmental sensitivity, community requirements, defence necessities and transport. Many government agencies are responsible for these environments, with many having overlying responsibilities and agendas. Therefore, in order to manage the coastal zone in an effective and efficient manner an integrated approach is required.

ICZM can thus be considered a process whereby decision makers act in a coordinated and integrated manner, thus reducing costs and minimising the use of resources from uncoordinated and duplicative management. ICZM recognises that the multiple units within and among governments, and the

stakeholders they represent, must join together so as to manage the appropriate boundaries of the ecosystems and/or physical systems that are in need of management [4].

In the School of Engineering at Griffith University, ICZM is taught in one course, namely 4084ENG Coastal Zone Management. Many other universities have similar courses within their undergraduate programmes. The major objectives of this ICZM course are to assist students in developing an understanding of management issues, techniques and methods available for ICZM, and to investigate the legislative, political and social factors involved in ICZM. Therefore, it is an important course of study for any coastal engineer to complete, and thus should be integrated into relevant undergraduate programmes by the most suitable means [5].

What is an Industry Affiliates programme?

Industry Affiliates Programmes (IAPs), which are sometimes referred to as cooperative education, is an educational mechanism whereby students learn through practical guided experiences. Typically, an IAP involves students learning by undertaking study programmes within their professional environment, which, for coastal engineering, would involve students undertaking study-oriented activities within the active coastal engineering industry (eg government agencies and consultancy companies). That is, the student would be located and learn away from the academic institution.

IAPs are a valuable tool for assisting with student learning. According to Martin,

... twenty years of research into student learning in higher education has established that students learn more effectively when they experience supportive teaching, high quality feedback, a challenging but not over-heavy workload, and clearly-stated goals and standards [6].

Indeed, the assumption that vocational and professional education within universities should have a practical and theoretical element has been well documented [7-9].

Numerous IAP models have been developed and introduced, with their principle objective being to enhance student learning through *industry-guided* activities. These models can be broadly classified into three categories, namely: traditional sandwich courses, cognitive apprenticeships, and cooperative education for enterprise development models (CEED) [8][10].

The IAP adopted by Griffith University was based on the CEED model approach [10]. The aims of a CEED programme extend beyond the professional experience of students and promote student development through a student-university-industry partnership in training and innovation [8]. Effective CEED programmes provide the employer with the opportunity to capitalise on the accumulated expertise of both the student and the academic staff. The programme is structured so that students are not regarded as a source of cheap labour, but rather as a contributor to the operations of the organisation. These programmes achieve their objectives by being structured and tightly managed, and operate on the basis of a series of firm contracts where the benefits for all parties are made explicit [10]. In these programmes, students spend the vast majority of the working week at the location of the industry partner and are

assigned distinct tasks with defined deliverables. The industry partner has a set role in this process, as does an academic supervisor from the host university. The student works primarily under the guidance of the industry partner but also has direct guidance from the university (albeit at a significantly lower level).

The CEED education programme for Griffith University (referred to here as the Coastal Engineering Industry Affiliate Programme – CEIAP) is conducted during the entire first semester of the final year of the four-year Bachelor of Engineering in Coastal Engineering degree. The CEIAP involves the placement of students with an industry partners for four days per week. This is coupled with campus-based activities for one day of the working week, during which the students attend lectures, meet other CEIAP students, obtain guidance from University supervisors, and present their project findings. Students must meet specific requirements before entry into the CEIAP, including the successful completion of a minimum number of preparation courses [10].

Student performance is assessed by various mechanisms that evaluate a number of key learning outcomes. With these expected learning outcomes, certain required graduate attributes and several components of student development including project planning, presentation skills, communication skills, report writing, and professional conduct, should be enhanced [10].

The on-campus activities are also utilised in the student education of ICZM, supporting what they can learn from their industry activity. That is, ICZM education is formally integrated into the CEIAP. Students complete all components in the course of 4084ENG Coastal Zone Management, so that they are assured of having obtained some degree of education in ICZM, while the industry placement can reinforce this through actual work in the area of ICZM. The activities add to the knowledge base of the student; reflecting the primary purpose of the Bachelor of Engineering in Coastal Engineering to provide a practical professional education. The ICZM class also reminds students that they are actually undergraduates and not employees of their industry partner.

COURSE EVALUATION

It is required and good practice to evaluate the courses within educational institutions. The CEIAP programme, while still in its infancy (as it began in 2003) has undergone an initial qualitative evaluation process. This was achieved through direct discussions with the industry partners and the students. As the number of students who have completed the programme is limited, it has not yet been possible to obtain detailed quantitative evaluation data.

Table 2 presents some of the comments from the students involved thus far when asked about their overall thoughts of the CEIAP. Their comments indicated that the students strongly felt they had benefited from the focused hands-on industry projects they were assigned. Interestingly, they all revealed the importance of the programme in developing their employment opportunities, rather than engineering content. This was certainly a positive, because the CEIAP aimed to enhance the overall quality of the students, including developing their professional attitude. This covers attributes 6, 7 and 9 as presented in Table 1.

Table 2: Some student perceptions of the programme.

<i>What are the best aspects of the programme?</i>
Getting experience in working in an engineering environment.
It helps you get a feel for the workplace, it is very good experience and will give me a lot more confidence when I finish my degree.
This programme gives us as students an opportunity to participate within a working team, something that we would not get to do if we were still studying. I feel it gives us a head start, and shows a potential employer we can work in an office situation.
Contacts made in the industry which led to employment.
Working in the industry and having the chance to experience what it takes to work in consultancy.

Table 3 gives some of the comments made by the students involved with regard to their overall thoughts of the course. While being generally very supportive of the educational process and the benefits they gained, one student felt that more technical content should have been delivered. This point raises the issue of project selection more than the quality of the CEIAP programme. As discussed in Lemckert, it is essential that care be taken in placing the student in an appropriate position [10]. In this particular case, the student would have been better placed within a project of high technical content. However, as students will probably find out, not every project they will undertake following graduation will be what they want or expect. Thus, the programme has realism, and hence good practice for their future careers. It is noteworthy that the student (last respondent in Table 3) still gained a great deal from the CEIAP, albeit not in their preferred area. Overall, generic skills 2, 4, 5, 6, 7, 8 and 12 were certainly addressed and probably enhanced.

Table 3: Further comments on their perception of the programme.

<i>Overall, how would you rate the programme as a teaching/learning tool?</i>
You can't get this kind of experience in the classroom.
It allowed me to focus my energy and hence I achieved a very good result.
Yes. That subject in particular opened my eyes to some issues involving sustainable development.
This programme is great for a learning and teaching tool. I feel I have learnt more in these three months or so, than I have in the past 3 years. Of course this is probably not true, but it feels that way because I can remember it. I can explain why something happens with confidence in knowing what I am saying is correct. This is extremely important in engineering. This is because I am working towards an outcome, and it employs my knowledge that I have acquired.
While I learned how to manage lots of projects and how to go through the state and local government requirements for funding, approvals, getting councillors on your side, one thing I will say is from an engineering point of view I have learnt very little. I have been managing and understand managing very well, but I have done about 1 hour of technical work so far and that was simply working out if the sandbags would move in a Q100 flood. From the management point of view this experience is priceless, but from technical I haven't done much at all

The students were also asked to comment on the issue of their perceived learning of ICZM. Their responses, presented in Table 4, reveal that for some the entire CEIAP was very beneficial. However, for others the on-campus ICZM course material was essential, as it was their only real learning opportunity. This indicates that the CEIAP achieved its desired objective of enhancing students' knowledge, albeit more effectively with some than for others. While not presented here, the performance of students during the on-campus activities showed that they had achieved a high standard of learning in ICZM.

Table 4: Students' thoughts on the inclusion of the on-campus teaching activity.

<i>Do you feel the programme is assisting in the development of your knowledge on coastal zone management? Why?</i>
Yes, but only because of the coastal zone management course, otherwise no.
Yes, because I get to work for a company and deal with real life CZM issues.
Yes. That subject in particular opened my eyes to some issues involving sustainable development that I was previously unaware of.
Yes, from dealing with the general public, to workers, to very knowledgeable state government officers and having to give my boss results and when there is a complaint having to explain what we are doing and why this will work.
It has definitely assisted me in developing my knowledge on coastal zone management ... While working on this programme, I have realised the need for coastal zone management.

From the student comments presented in the above tables, from observations made during visits by the author to the industry partner workplaces, and through informal discussions with the students, it was evident the students were very pleased with the CEIAP. They felt that while significant learning could be gained from their industry project within the area of ICZM, the on-campus activities helped those whose projects were not directly related to ICZM.

From a CEIAP management point of view, it was evident that the activity requires sound academic management in order to ensure that students remain focused on their work and gain the most from their CEIAP. This also requires the industry partner to appreciate both the requirements and the benefits of the CEIAP [10]. While most of this can be explained through direct university-industry partner discussions, it is only through the implementation of the CEIAP that industry partners gain full appreciation. Therefore, such programmes take time to establish their credibility and presence within the community. Consequently, they must be given time to mature.

CONCLUSIONS

The development of an IAP to assist in the education of undergraduate students has been undertaken for the relatively new area of coastal engineering. The developed programme involved the use of a CEED-type model whereby a university,

an industry partner and the student form a cooperative team whose focus was to enhance student learning. Student perceptions revealed the developed programme did enhance their learning and gave them the opportunity to develop generic engineering attributes, an outcome supported verbally by their IAP partner.

Through appropriate design (which required students to undertake ICZM on-campus classes as part of the CEIAP) the developed programme was used to enhance ICZM learning, even if the student's industry project was not directly within the area of ICZM. As such, it is recommended that such schemes should be adopted when the resources and appropriate support (including the availability of an industry partner) are available.

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REFERENCES

1. Dalrymple, A., The Coastal Engineering Page (2002), <http://www.coastal.udel.edu/coastal/coastal.html>
2. Johnson, P. (Ed.), Changing the Culture: Engineering Education into the Future. Barton: Institution of Engineers (1996).
3. Kay, R.C. and Alder. J., *Coastal Planning and Management*. London: Routledge (1999).
4. Kildow, J., The roots and context of the coastal zone movement. *Coastal Management*, 25, 231-263 (1997).
5. Plink, N.L., Training and education in integrated coastal zone management. *Ocean and Coastal Management*, 41, 273-279 (1998).
6. Martin, E., The Effectiveness of Different Models of Work-Based University Education. Canberra: Australian Government Publishing Service (1997).
7. Longworth, W.R., Cooperative Education: Cooperation between Industry and Advanced Education in Teaching Programmes, Evaluations and Investigations Programme. Canberra: Commonwealth Tertiary Education Commission (1987).
8. Baumgart, N., Kouzmin, A., Power, A. and Martin, A., Evaluation Report on the Cooperative Education for Enterprise Development Programme (CEED). Canberra: Australian Government Publishing Service (1994).
9. Davies, A.T. and Hase, S., The Conditions for Fostering Cooperative Education between Higher Education and Industry. Canberra: Australian Government Publishing Service (1994).
10. Lemckert, C.J., A coastal engineering industry affiliates programme model to enhance student learning. *World Trans. on Engng. and Technology Educ.*, 2 3, 417-420 (2003).