AN INTERDISCIPLINARY APPROACH TO EDUCATION: CASE STUDY OF AN ACADEMIC EXCHANGE

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SUMMARY

As the challenges faced in today's world are increasingly complex, a large number of specialised individuals now need to collaborate together to combine their expertise. Since the professional world is interdisciplinary, the learning and teaching provided in higher education must adapt and consider the interdisciplinary approach, very clearly encouraged in the United-Kingdom by both the Higher Education Academy and the Department of Business, Innovation and Skills. Building on the known benefits of interdisciplinary education, an academic exchange between boatbuilding and yacht design students has been conducted to develop and validate an interdisciplinary learning pedagogical model. Primarily focussed on the maritime field, the proposed model has three bases, learning, reflexion and capabilities, respectively supporting studies, bridging the skills gap and enhancing employability, thereby answering the contemporary demands from both students and the maritime industry.

1. INTRODUCTION

In every discipline, there is a greater need for specialisation, leading to a larger number professionals collaborating to solve increasingly complex problems. This has long been identified in the medical field, where specialist health professionals must interact to provide the patients with the best and most appropriate level of care [1]. As a result of the need for interdisciplinary teams, health care education had to adapt and implement interdisciplinary teaching and learning, becoming over the decades a well-established tradition [2].

The maritime industry is now facing the same challenges. With the development of technologies, professions have become more and more specialised, and a design project now requires a joint effort from all parties to achieve the vessel desired by the client. However, this is not so easily achieved, and communication is often an issue. The stylist, naval architect and builder will all have different views, each with specific concerns that the others may not have identified [3]. The success of the design heavily relies on the ability of the multiple stakeholders to interact, thus suggesting an interdisciplinary approach to education should be brought into the maritime industry.

The background and benefits of interdisciplinary education will be presented and related to the recommended educational practices in the United-Kingdom, with an emphasis on applications in the maritime field. Finally, a case study of an interdisciplinary exchange between yacht design and traditional boatbuilding students will be detailed to support the implementation of an interdisciplinary approach and validate the proposed pedagogical model.

2. INTERDISCIPLINARY EDUCATION

2.1 INTERDISCIPLINARY APPROACH

Early instances of interdisciplinary education can be traced back to the *curriculum integration* concept promoted in the 1930s [4]. But interdisciplinary education really emerged in the 1970s [5], with a rich literature and the development of key definitions. Kockelmans [6] defines interdisciplinary as: *"to solve a set of problems whose solution can be achieved only by integrating parts of existing disciplines"*. All later attempts at defining this concept always came back to the need for the synthesis of two or more disciplines [7], and the idea of a problem that cannot suitably be resolved with a single approach [8], allowing to construct new ways of creating knowledge.

The need for interdisciplinary arises from the ever increasing complexity of the problems to solve [9], and modern challenges are very much interdisciplinary, or as stated by Dezure [10]: "*life is interdisciplinary*". It is therefore critical for education, and indeed higher education [11] to consider the benefits of an interdisciplinary approach, and for the maritime industry to implement its practice.

2.2 BENEFITS

Perhaps surprisingly, one of the main, and often neglected benefits of interdisciplinary education is allowing the students to reflect on their specialty and realise what their discipline really is. Indeed, the argument brought forward by Eckert [12] is that: *"Students really aren't that clear about what the various disciplines do. What students really need to know is what a discipline is."*

The most encountered benefit is the opportunity for the students to link ideas and concepts across varied disciplines, prompting a constructive paradigm that makes for a deeper understanding. A non-exhaustive list of the benefits of interdisciplinary learning and teaching as reported by Nissani [13] and completed by Appleby [14] includes:

- More meaningful learning experience.
- New opportunities resulting from the cross-overs between two disciplines.
- Demonstrating real life applications.

- Varied perspective.
- Flexibility in problem solving.
- Bridge the communication gap between professionals.
- Critical thinking.
- Building confidence.
- Greater creativity.
- Transferable skills.

From the benefits highlighted, the concept of WBL (work-based learning) pedagogical triangle developped by Brodie and Irving [15] can be adapted into a preliminary interdisciplinary learning (IDL) triangle, as presented in Figure 1.

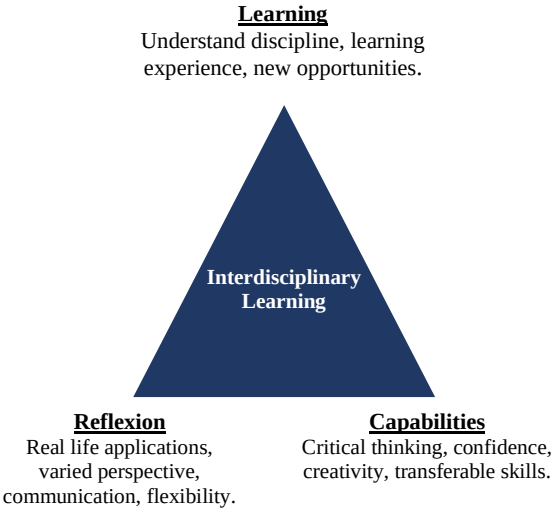

Fig. 1: Preliminary interdisciplinary learning (IDL) pedagogical triangle, adapted from [15].

2.3 INTERDISCIPLINARY EDUCATION IN THE UNITED KINGDOM

In the United Kingdom, interdisciplinary learning and teaching is encouraged at various levels. The UK Professional Standard Framework (UKPSF) [16] specifies that fellows of the Higher Education Academic should engage in *"developing interdisciplinary or professional/work-based resources"*. This is also suggested in the Teaching Excellence Framework (TEF) published by the Department of Business, Innovation & Skills [17], stating that: *"The challenges facing the world are complex, and increasingly require multi- or inter-disciplinary approaches"*.

Finally, at a more local level, it is part of Southampton Solent University's strategic plan for 2015-2020 [18] to *"develop cross-institutional research groups based on interdisciplinary areas and addressing real-world issues"*.

The interdisciplinary approach is therefore recognised and encouraged at a national level in the United-Kingdom, and its benefits are further promoted by the UKPSF, the TEF and Southampton Solent University.

2.4 INTERDISCIPLINARY LEARNING AND TEACHING THE IN THE MARITIME INDUSTRY

At the heart of the maritime industry are transferable skills; a major benefit of the interdisciplinary approach. Indeed, most technologies in the relatively small maritime industry directly come from larger industries, such as the automotive or aerospace industry, and there is a large number of very specialised fields within the maritime industry. This is one of the elements of the *skills gap* [19], defined as the difference between the employer's expectations and the graduate's capabilities. In fact, the interdisciplinary pedagogical triangle proposed in Figure 1 seems to highlight most of the key skills required by the industry, but that graduates lack. Answering the call for those specific skills in the maritime sector will result in enhanced employability [20], and will also benefit the industry by bridging the communication and interaction gaps between disciplines that appears to be a current issue faced by the superyacht industry [3].

Building on the previously presented IDL triangle, a refined model is presented in Figure 2 on the next page, with the addition of the final outcomes, namely enhancing employability, supporting the studies and bridging the skills gap, respectively supported by the capabilities, learning and reflexion resulting from the interdisciplinary experience.

A strong case can therefore be made in favour of an interdisciplinary approach to education in the maritime industry, which is the primary motivation behind the pilot academic exchange conducted between Southampton Solent University and the International Boatbuilding Training College (IBTC) Portsmouth, in order to validate the proposed IDL triangle model.

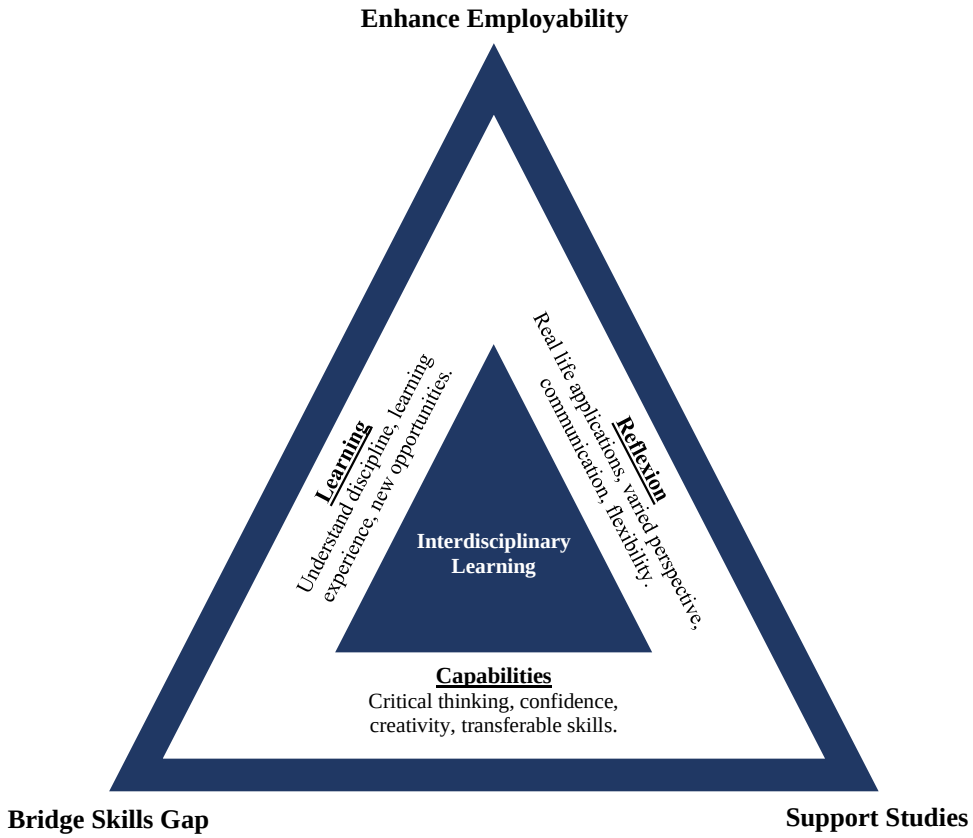

Fig. 2: Interdisciplinary learning (IDL) pedagogical triangle.

3. CASE STUDY OF AN ACADEMIC EXCHANGE

3.1 MOTIVATIONS

In order to assess the benefits of an interdisciplinary approach in the maritime industry via a case study, an academic exchange has been realised between yacht design students from the BEng (Hons) Yacht and Powercraft Design and BEng (Hons) Yacht Design and Production courses at Southampton Solent University, and traditional boatbuilding students from the Practical Boatbuilding course delivered at the IBTC Portsmouth. The exchange took place over a week in the spring of 2016, and involved 13 Southampton Solent University students from first (level 4) and second year (level 5), as well as 12 IBTC Portsmouth students (level 3).

3.2 IBTC PORTSMOUTH STUDENTS

The content of the academic exchange delivered to the IBTC Portsmouth students has been designed to support and extend the syllabus of their Practical Boatbuilding course, as defined in [21], making full use of the specialist facilities at Southampton Solent University, and revolving around a series of lectures, practical activities, and demonstrations.

The lectures reinforced key elements of the practical boatbuilding course such as timber technology, but also brought new knowledge in basic naval architecture and yacht design, thus allowing a wider understanding and helping future collaboration with designers. The practical activities built on their experience, but pushing the skills outside of their normal comfort zone, moving from traditional timber to modern composite. Figure 3 depicts the manufacturing of a model yacht hull in a female mould-tool, emulating a representative scaled-down version of the composite boatbuilding industry.

Fig. 3: Composite manufacturing.

Lastly, to provide an insight into other aspects of the industry, a cored infusion and the towing tank testing of a stabilized-monohull (see Figure 4) were undertaken.

Fig. 4: Towing tank demonstration.

From the IBTC Portsmouth students' perspective, the interdisciplinary exchange conducted was successful in supporting their studies, helping them acquire new skills and knowledge, and in their opinion enhancing their future employability.

3.3 SOUTHAMPTON SOLENT UNIVERSITY STUDENTS

The recent improvements made to both yacht design degrees at Southampton Solent University saw the addition of a stronger emphasis on practical skills, as directly required by the industry [22]. This is however restricted to composite manufacturing. The syllabus designed for the Southampton Solent University students therefore revolved around practical activities focussed on wooden boatbuilding.

Firstly, to introduce the students to the use of hand tools, as well as working with wood, all manufactured a traditional mallet from a given drawing. Conversely to their normal studies where they would draw a plan aimed at the builder, they are now given the plan and need to build from it. This allows them to better reflect on what to provide a builder on construction drawings and will enhance their drafting skills in the future.

Students then discovered skills specific to traditional boatbuilding, namely steam bending ribs, and roving, illustrated in Figure 5. While both techniques are taught theoretically as part of the course, it is an invaluable experience to realise how flexible steamed timber is, and how much labour goes into roving; knowledge that will feed back into future design projects of the students.

Fig. 5: Roving a steam-bent rib.

Finally, the students were tasked with taking the scantlings off a WWII lifeboat and draw plans that would enable a replica to be built. On completion, the existing boat, beyond repair, was entirely deconstructed by the students, providing fantastic opportunities to better understand the assembly process and to see an actual cross-section through a vessel, as shown in Figure 6. From the offcuts, students were given the opportunity to build their own creative project, ranging from a stool to a skateboard.

Fig. 6: WWII lifeboat deconstructed.

Through a series of practical tasks, the students were able to apply theoretical knowledge of materials, construction techniques, structural arrangements and design learnt during their course. This is supplemented by practical experiences leading to new skills and deeper understanding, as highlighted by the feedback gathered.

4 STUDENT FEEDBACK AND IDL PEDAGOGICAL TRIANGLE VALIDATION

In order to gauge the value of the exchange for the students, a short survey was realised; this comprised two sections: a multiple-choice satisfaction survey, and an opportunity for the participants to provide written feedback.

4.1 SATISFACTION SURVEY

A primary objective was to support the students' learning through an interdisciplinary exchange, with an increased employability as a final outcome. Student were therefore questioned on the academic relevance of the exchange, i.e. how they felt it would benefit their current studies. Furthermore, the professional relevance of the exchange assessed the students' view on how beneficial the exchange would be on their employability. In both cases, all students from both institutions positively responded (either satisfied or very satisfied). In addition, the interdisciplinary approach has allowed the student to develop new practical skills and gain further knowledge. Figures 7 and 8 depict the very strong satisfaction of the IBTC and Southampton Solent University students respectively.

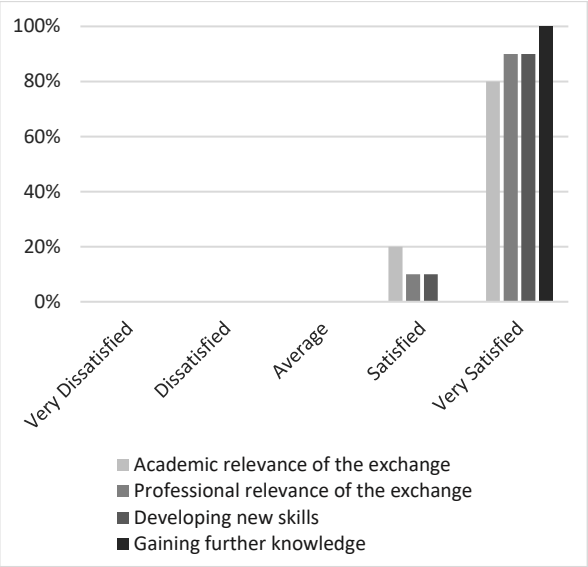

Fig. 7: IBTC students' satisfaction.

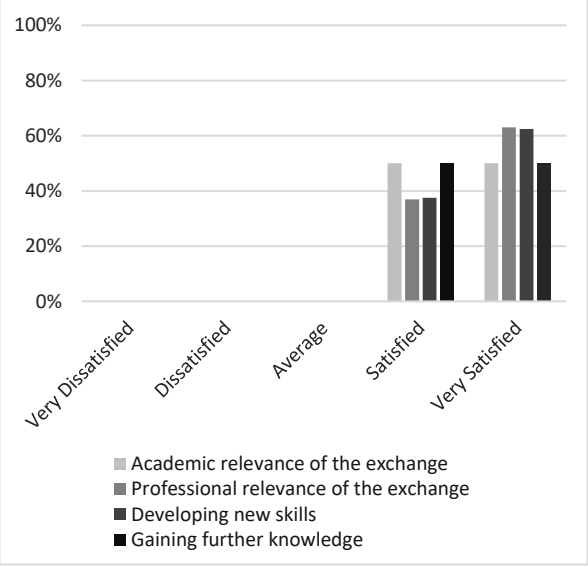

Fig. 8: SSU students' satisfaction.

The students very clearly identified the value of the interdisciplinary exchange to support their current studies and future careers. All positively ascertained that new skills were developed and further knowledge gained.

4.2 WRITTEN COMMENTS

Comments from the students all proved to be very positive, and participated in the validation of the IDL triangle model presented earlier in Figure 2, revolving around three core values: learning, reflexion and capabilities, each respectively contributing to support their studies, bridge the skills gap and enhance employability.

Evidence of the learning benefits, in terms of understanding the discipline, creating a valued learning experience and new opportunities, is supported by the following statements:

- *"The course was great in helping me understand the classic side of things and the sort of things I need to consider when designing a wooden boat"* (SSU Student).
- *"One of the best experience of the year."* (SSU Student).
- *"Accessible to all, enriching and stimulating."* (SSU Student).
- *"Surprisingly fun week and I think the educational outcomes will be shown in the exams at the end of the year. I really enjoyed the exchange to IBTC, it helps me develop skills and gain new ones."* (SSU Student).
- *"Great learning experience and a really insightful look into wooden boatbuilding and restoration."* (SSU Student).
- *"A very worthwhile exchange"* (SSU Student)
- *"Competence which extend beyond the scope of the course."* (SSU Student).
- *"Really enjoyed the course and gave me a view how these classic boats are build, or how they are able to make replica from those"* (SSU Student).
- *"It certainly opens a real of possibilities"* (SSU Student).
- *"Very interesting to gain knowledge into the design of boat."* (IBTC Student).
- *"Good to move away from the totally practical side of things."* (IBTC Student).

The reflexion aspect, looking at real life application of concepts discussed in lectures and offering a varied perspective is also strongly validated by the students' comments, despite a lack of direct recognition for the benefits inherent to inter-professional communication.

- *"Value of experimental learning."* (SSU Student).
- *"Field application of theoretical aspects covered in class."* (SSU Student).
- *"Put into practice what was learnt in the lectures."* (SSU Student).
- *"Great fun, interesting and practical, we all left having learnt something new and enjoyed ourselves."* (SSU Student).
- *"The course was overall beneficial to my academic studies as it first was very relevant to one of the six subjects that I currently study of marine materials and so provided a practical platform to what we had studied for example the steam bending of wood was covered in lectures so it was good to see this done outside of the class."* (SSU Student).
- *"Useful to understand aspects of hull design."* (IBTC Student).
- *"A great look at the design side of things."* (IBTC Student).
- *"Different perspective and ideas on construction and construction methods."* (IBTC Student).

Finally, the capabilities, whether it is critical thinking, confidence, creativity and transferable skills are highlighted in the students' responses:

- *"The course at IBTC made us appreciate how much work goes into building a boat"*. (SSU Student).
- "*Practical skills, complements our university courses."* (SSU Student).
- *"It was a really productive course that helped understanding and consolidate the previous knowledge. There should be more initiatives like this."* (SSU Student).
- *"It will certainly give some confidence when drawing anything wooden for Grant (lecturer setting an exam on wooden construction – Ed.)"* (SSU Student).
- *"I really enjoyed the exchange to IBTC, it helped me develop skills and gain new ones making me more confident to build my model yacht".* (SSU Student).
- *"Loads of good ideas"* (SSU Student).
- *"And we even got to make our own creation"* (SSU Student).
- *"A great deal of boat knowledge, applicable to all types of boats, was acquired."* (IBTC Student).

The case study of this exchange appears to validate the benefits of the interdisciplinary approach, with evidence of learning, reflexion and capabilities developed, perceived by the students as supporting their current studies and having a positive impact on their future careers, thus bridging the skills gap. There is therefore supporting evidence to validate the proposed IDL triangle model in the maritime industry.

4.3 FURTHER WORK

This pilot exchange is now set to be organised as a yearly event, this will provide a platform to further evaluate the interdisciplinary model. Future work includes a new survey questionnaire, better aimed at targeting each aspect of the model for a more precise and quantitative validation. Looking at the medium term impact on students who took part in previous editions of the academic exchange is also planned to assess any significant impact on their studies and early career. Finally, the model is to be extended to other fields of studies than the maritime industry to generalise the concept.

It is worth noting that, despite a majority of the students asking for this particular exchange to be run over a longer period, it will not be extend beyond the current week it has been conducted over. Indeed, as noted by Kanikia [23] and further supported by Jones [24], a major focus on interdisciplinary can lead to an isolation from the original core of the field of study. Furthermore, issues can arise if interdisciplinary itself is considered a primary field of study [25].

This precise exchange programme is therefore to remain relatively short, and not extended. However, providing students with similar opportunities, with an alternative discipline in another year of their degree would appear a more suitable approach.

5. CONCLUSIONS

An interdisciplinary approach to education has long been praised due to its multiple benefits. In the United-Kingdom, its practice is supported at a nationwide level by the UK Professional Standard Framework and the Teaching Excellence Framework, as well as locally through Southampton Solent University's specific strategy for instance. Moreover, it appears a necessity in the maritime industry to reinforce interdisciplinary learning and teaching to promote employment and better solve issues currently faced by the industry.

To ascertain the benefits of this educational approach, a one week exchange has been conducted between the yacht design students of Southampton Solent University and the traditional boatbuilding students of the International Boatbuilding Training College Portsmouth. The exchanged revealed a very high satisfaction from all students and allowed to validate the proposed interdisciplinary learning (IDL) pedagogical triangle model. The benefits of interdisciplinary learning leads to three primary bases:

- Learning, which enables the students to better understand their own discipline, promotes new and motivating learning experiences as well as new opportunities.

- Reflexion, demonstrating the real life applications of a studied theory, promoting varied perspectives on a given topic, which then improves inter-professional communication and gives a higher flexibility in problem solving.

- Capabilities, to develop critical thinking, gain more confidence and promote creativity; the end result being to acquire the much needed transferable skills for professional purposes.

Those three bases of the triangle then turn into concrete outcomes, respectively supporting the student's studies, bridging the skills gap, identified as a primary issue in the maritime industry, and finally enhancing the employability.

If the proposed model appears to be supported by the literature and validated thanks to the case study, future work will look at additional validation, and the extension to other fields and industries, in order to generalise the proposed IDL pedagogical triangle, and better understand the place and role of the interdisciplinary approach in higher education.

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