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PEER MENTORING IN MULTIDISCIPLINARY FINAL BACHELOR'S THESIS OF ENGINEERING STUDIES

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Abstract

This work presents the results of implementing near-peer mentoring as a tool to facilitate the guiding of students developing their bachelor's thesis (BT) in the field of engineering studies. This strategy was found to be necessary as the BT were developed within a multidisciplinary research project in which it was important to ensure project's continuity and quality. Bachelor's Thesis (BT), typically done during the last semester of the final course of engineering studies, needs to be defined as a practical activity, as closer as possible to actual engineering professional practice. The possibility of developing the BT in a complex, collaborative, transdisciplinary, and practical project marks a difference in the skills acquired by students during its development. Initiative, autonomy, creativity, work organization, critical thinking, abilities for teamwork, and project management skills are valuable tools highly valorised in engineering professional practice. Therefore, involving students in ongoing complex practical projects as part of their BT is an optimum way to ensure the acquisition of learning goals in engineering studies while they acquire a valuable working experience. Nevertheless, it is difficult to combine the schedule of a 6 months' long work, as BTs are, with longer research projects, and the organization of both tasks is often demanding and complex. It is particularly important to keep a continuity in the process' development, so that results and valuable acquired knowledge is not lost in the transition from on student to the other one. For this purpose, peer mentoring can be a valuable tool, to reinforce the student guiding, learning, motivation, and empowerment towards a successful completion of the attributed work tasks. Results showed that peer mentoring was a useful strategy to help students not feeling lost during the developments of the practical tasks associated to the project to move in a more fluent way through the transdisciplinary contents. Students felt that the combination of peer and academic staff's guidance was important for an efficient transition between consecutive BT works without losing performance in the global project. Mentors reported to feel an extra workload related to the challenge of guiding peers, but, at the same time, they positively valued the implied motivation, the feeling of a sense of community, and the establishment of peer-mentoring relationships. Mentees highlighted the emotional support and the value of interdisciplinary collaboration for academic outcomes.

Keywords: *Peer learning, engineering studies, bachelor's thesis, transdisciplinary projects.*

1. Introduction

The present learning experience has been performed with students of Renewable Energies Engineering bachelor's degree at the University of the Basque Country, UPV/EHU. This is a four-years' degree composed by two years of fundamental engineering courses plus another two years of specific subjects related to renewable energies (technologies, installations, costs, etc.). The renewable energies sector is experiencing significant growth, which materializes in an increase of the demand of specialized professionals for a wide range of jobs in areas as manufacturing, consulting, design, construction,

installation and commissioning, operation and maintenance, or research and development. Therefore, there is a necessity to engage the needs of this industrial sector and the skills, knowledge and competences acquired by the students of these engineering degrees for a successful match into capable and competitive professionals (Beagon et al., 2023). In the second semester of the fourth-year students develop the final bachelor's thesis (BT) as the final task before graduation. BT in engineering studies often includes experimental and practical tasks, and it is related to the learning of research methods. Students are expected to cover learning outcomes as literature survey, project design and development, scientific research ability, report writing and defending or knowledge in giving and receiving scientific critique. BT should represent an actual engineering professional practice, so it is remarkably interesting for students to develop the BT in collaborative, open-ended, cross-disciplinary, complex socio-technical projects. This opportunity will make a difference in the skills acquired by students during its development (Tejedor et al, 2019). Nevertheless, guiding and evaluating students BT' through this type of complex projects is often a challenging task in which they can get lost and face non-desired consequences which may delay or prevent from a successful completion of their BT.

Near-peer mentoring (NPM) has been identified as an effective tool to facilitate the guiding of students developing their BT in engineering studies (Andrews & Clark, 2011). This work describes the experience and results of using NPM to coordinate BT-students through complex cross-disciplinary-research projects. Two goals were prioritized in the guiding strategy; the first one was to establish the basis to ensure project continuity and quality and the second one was to define a balanced and robust evaluation system as the core of the NPM development. The following sections will describe the structuration of the NPM as an effective strategy to ensure a successful mentors-mentees relationship and BT-students' continuation and completion rates.

2. Methodology

Various terminologies are used to describe mentoring activities in the literature (guiding, tutoring, assisting, coaching), reflecting the complexities of the term (D'Abate et al., 2003). Moreover, published studies report mentoring experiences applied in different scenarios and circumstances, for example, to welcome first-year-students and give assistance with acclimatising to university life, or to help with non-study related matters as personal problems or difficulties with culture or language. Andrews and Clark defined seven diverse types of peer mentoring (Andrews & Clark, 2011), as briefly summarised in Table 1.

Table 1. Typology of peer mentoring (PM) (adapted from Andrews and Clark, 2011).

Peer mentoring (PM) type	Mentor	Mentoree	Characteristics
Pre-entry PM	Existing students	Future students	Offered to all first year-students.
One-to-one PM at transition	More experienced students	New students	Offered to individuals or small groups. Careful matching and appropriate academic requirements.
One-to-group PM at transition	More experienced students. Typically, one mentor to four or five mentees.	New students	Provides a 'friendly face' upon arrival making transition positive for students. One mentor to four or five mentees.
One-to-one longer-term PM	More experienced students	Less experienced peers or peers at same level.	Mentoring pairs carefully matched, with close supervision of student pairings. Relationships often last throughout the university career and beyond.
One-to-group longer term PM	Mentoring partners can be at same or distinct levels of study		Mentors may need support with group dynamics. Usually organised across a year group.
Partnershipled PM	Two peer mentors at same or higher level of studies.	Small group of 4-10	Can be long or short term (inter or intra year basis).
Group PM	A group of students working together with the aim of mutual support. Usually, mentors and mentees from same year.		Usually offered on a short-term basis. Resource intensive as management of groups may be problematic.

This work describes the use of NPM for BT-students who are about to complete their last task before graduating, so, in this case, the goals and boundaries of the NPM are quite specific and focused in passing down knowledge regarding project' organization, development and completion to a less experienced colleague. The main characteristics of the NPM used strategy are described in Table 2.

Table 2. Main characteristics of the NPM used strategy.

Project coordinator	Director of the BT who acts as coordinator of the group of professors from different disciplines involved in the project development.
Mentor	Student who has completed his/her BT in a complex, cross-disciplinary project and is about to defend it.
Mentee	Student who is starting her/his BT in the context of the same project.
Temporal contextualisation	Last semester of the fourth year of the bachelor's degree.
Goal	- Ensure BT-students' continuation and completion rates. - Fulfil the project milestones within established deadlines
Strategy	- The project coordinator together with the rest of professors proposes potential BT works to be developed within the project by new students. Each of them is suitable BT according of the learning outcomes that the student should acquire to finish the engineering bachelor's degree. - A call is open for students willing to develop their BT as part of the project. - Proposals are evaluated and a match of mentors and mentees is proposed, discussed, and accepted. - Each mentor makes available the following information to her/his mentee: • Getting started: basic information about the content of the project. • Project contextualisation. • State of the art: what has been already done and current situation of the research work. • Definition of goals and contents to be covered as his/her BT: learning outcomes, associated experimental tasks, involved cross-disciplinary concepts, milestones, deadlines, expected results, contingency plan. • Presentation of the working team: professors and mates involved in the project development. • Definition of roles: project coordinator, laboratory responsible, task coordinator, milestone responsible, mentor, mentee. • Definition of handouts: laboratory diary, weekly report, monthly group presentation, task report, BT final document. • Definition of the evaluation procedure (see evaluation section).
Requirements	Students need to cover several compulsory fulfilments to defend their BT: • Get a positive evaluation by the BT's director and ALL professors involved in the project development, as well as by her/his mentor. • Have completed within deadline all required tasks and associated handouts. • Acquire the compromise of mentoring a new student to work together during the last half of her/his BT. • Have participated, together with the project coordinator and professors' team, in the recruiting of new students who will develop their BT in the next call, and match each of them (new mentee) with a mentor. • Participate in the annual student's day organized by the UPV/EHU with a poster presentation including the main highlights of the BT.
Evaluation	- Evaluation is done accordingly to the official procedure of the UPV/EHU for BT. - When the student completes the tasks and prepare the final report, it is sent to the BT's director and to the rest of professors involved in the project development, as well as to her/his mentor for approval. They will give feedback for amendments up to the accepted last version, which will be uploaded to the public repository of the UPV/EHU. From this moment on, student can start the procedure for the BT defence. BT's director will send a report with the evaluation of the report which entails the 25% of the final mark. - A panel of three professors will be evaluate the final defence and their mark will entail the other 75% of the final mark.

3. Results

Follow-on surveys were conducted to receive feedback from mentors and mentees and capture their perspective about the NPM experience. The survey included questions related to the personal, social, and academic impact of participation in the mentoring programme. Statistical analysis is ongoing so, preliminary results have been extracted by the moment. Relevant issues about the implementation of

NPM were identified and classified as key themes and subthemes. Then, several relationships between them were established and will be further explored. Table 3 includes the main identified positive aspects and recurrently faced difficulties.

Table 3. Positive and faced difficulties related to the NPM used strategy.

Positive aspects	Faced difficulties
NPM worked as a link between the mentee and the BT's director and professor's team.	The introduction of the NPM programme needed a well thought through meaning a high workload for the involved professors.
Mentors and mentees agreed that their overall student experience had been enriched along the project development by applying 'learn how to learn' at a higher level, enhancing their sense of belonging, and exchanging on-going support.	Continuous support, training, and a level of on-going care and maintenance for mentors was required through the development of the BT.
Benefits realised in terms of student retention and success were considerable.	Rigorous mentor selection processes were required, which were time and energy consuming.
Mentors were able to develop valuable transferable skills to mentees, in terms of scientific competences and cross-disciplinary aspects, easing the process continuity and fluidity.	Pairing mentees and mentors to ensure successful matches was difficult sometimes and required attention to make modifications as soon as possible in case of incompatibilities.
Motivation to do well academically and to be involved was reported to be much higher than in the case of students developing their BT by themselves.	As a result of some unsuitable pairings, it was necessary to define a protocol to apply in these moments. At the beginning of the BT, students would accept to face changes in pairings if required by one of the mentors or mentees and accepted by the supervisor.
Personal and social benefits: satisfaction, identity development, listening and coaching skills, friendship, belonging, self-confidence.	It was difficult to make mentors feel part of the process of new BT students' recruitment, even if this was a compulsory activity within the requirements before starting to work in the project.
Improved transdisciplinary skills: self-management, leadership, communication skills, increased productivity, achievement, connecting and caring.	It was difficult to coordinate the students' official calendar calls to start and finish their BTs so that mentors and mentees could work simultaneously in the project for, at least, three months.
Improved research-related skills associated to a BT work: • Search for, read, understand, and summarize scientific papers and technical reports. • Identify key concepts and core knowledge. • Plan, organise, schedule, develop and finish experimental tasks on time. • Analyse, discriminate and discuss results, and extract related conclusions. • Give and receive scientific critique in a suitable register. • Synthetise the developed BT work and expose it in an appropriate way.	

4. Conclusions

As it can be concluded from the results summarized in Table 3, the presented experience has offered many positive aspects, even if several weaknesses needed to be corrected and many difficulties were faced during the design, implementation, development, and conclusion of the BT works in combination with the ongoing research project. The use of experienced students to guide and advise starting ones was felt as a big support by the involved professors and BT supervisors, specially in terms of continuity, effectiveness, timesaving, and management of experimental work and characterisation analyses. Indeed, the implementation of NPM has been the key to success in being capable of offering to the students the opportunity of developing their BT as a part of a bigger complex existing research project.

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