

Creating a Practical Transdisciplinary Learning in Teaching Construction Entrepreneurship

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Abstract : Construction Entrepreneurship is a unique subject taught in the Construction Engineering and Management program at the Universitas Agung Podomoro in Indonesia. As a new course, it is necessary to develop an effective and efficient teaching syllabus. This study describes construction entrepreneurship teaching through a transdisciplinary learning approach as an effective way to develop its syllabus. The transdisciplinary learning approach was chosen to provide insights into real-world problems to students through collaborative learning with industry speakers. Six construction entrepreneurs were invited to share their experiences in starting a construction business, followed by two reflective discussion forums to explore lessons learned from the sharing sessions. At the end of the term, online surveys were distributed to seek feedback from the enrolled students on the design, methods, and benefits of learning construction entrepreneurship. In addition, the survey was also intended to gather perspectives on the relevance and significance of this subject from construction students who had never taken it before. Overall, the approach to teaching construction

entrepreneurship to enrolled students was found to be effective. The statistics also reveal the high interest of students from other construction-related programs in taking this subject.

Keywords: construction entrepreneurship; entrepreneurs; teaching; transdisciplinary learning.

1. Introduction

The construction industry plays a crucial role in increasing socio-economic growth, especially in developing countries such as Indonesia (Setiawan & Erdogan, 2018; Rostiyanti et al., 2021). Likewise, innovation and entrepreneurship are critical factors for economic development (Sebastian & Alina, 2014). This is reinforced by Daniel's (2010) study of 77 countries, which confirmed that entrepreneurship has a significant positive effect on a country's economic growth. Similarly, Sebastian and Alina (2014), Malele (2020), and Alkhawaldeh and Dabaghie (2023) reveal the important role of entrepreneurship in countering unemployment and increasing living standards.

On the other hand, along with expectations for the university's contribution to solving socioeconomic issues such as unemployment (Taha et al., 2017) and improving living standards (Ndofirepi, 2020), many academic institutions promote entrepreneurship learning (Nsanzumuhire & Groot, 2020). Entrepreneurship has become a popular program at

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many universities in Indonesia. This leads universities to focus their attention on helping students develop entrepreneurial skills and knowledge (Ndofirepi, 2020; Silbereis, 2020).

According to Ayalp (2019), the construction industry provides numerous prospects for the development and dissemination of entrepreneurship knowledge. However, Construction Entrepreneurship (CE) has received little attention in construction management research (Sebastian & Alina, 2014). The available studies were mostly focused on the characteristics of a construction entrepreneur as well as its barriers and motives (Ayalp, 2019; Emmanuel et al., 2020; Jaafar et al., 2014; Sidek & Zainol, 2011; Setiawan & Erdogan, 2018). Several studies have focused on entrepreneurial potentials of specific construction professionals such as contractors (Jaafar et al., 2014), architects (Ayalp, 2019), and quantity surveyors (Sampath et al., 2020). There is only one study related to the exploration of entrepreneurship necessity in the construction program in Malaysia (Jaafar & Abdul Aziz, 2008). Thus, there is a research gap regarding how entrepreneurship should be taught to construction students.

This research focuses on evaluating the implementation of the CE syllabus as observed in a study program. This is important considering the idea of which single course is designed specifically to develop a particular comprehensive entrepreneurship competence recommended by Mindt and Rieckmann (2017) to achieve a specific learning outcome. In addition, this study attempts to explore students' potential interest in taking CE as a unique subject offered in construction-related disciplines.

2. Literature Review

A. Construction Entrepreneurs

The term entrepreneurship is vague and used differently by many researchers (Jaafar et al., 2010). For instance, Drucker (2014) defines it as "imagination, flexibility, creativity, willingness to think conceptually, readiness to take risks, ability to mobilize agents of production, and the capacity to see an opportunity". Others describe it as a process carried out by someone when starting up a company (Brandstatter, 2011) and a strategic process of developing an existing company (Yalcin & Kapu, 2008). Setiawan and Erdogan (2018) provide a more accurate definition as "a process of an individual

creating and/or running a business as well as the process within the company of attempting to gain new business and/or to manage the existing business with the aim to achieve business success that involves several specific characteristics, such as seeking opportunity, risk taking, creativity, and innovation."

Along with the development of the construction industry and technology, construction professionals are required to develop their competencies as entrepreneurs who will provide innovation in the construction sector (Chandramohan et al., 2020; Hansen, 2021a). The term "technopreneurs" may be used to refer to technology-based entrepreneurs (Belmonte et al., 2022). Despite the fact that it is very much needed, the number of construction entrepreneurs remains relatively low (Sampath et al., 2020). This is reflected in the Indonesian construction sector, which is only 4.09% (Utoyo et al., 2021) even though this sector contributed significantly to GDP by 10.48% in the 4th Quarter of 2021 (Rahmasari & Yuniastuti, 2022). In addition, the construction sector is also the least innovated business, with only 11.74% of companies innovating (Utoyo et al., 2021). This is caused by several factors inhibiting innovation, including reluctance for construction innovation (60.81%), difficulty in funding innovation (16.46%), lack of experts (24.54%), lack of knowledge to innovate (13.69%), and lack of supporting government regulations (9.50%). All these certainly have an impact on the growth and performance of the Indonesian construction industry.

One of the reasons for the lack of entrepreneurs in the construction sector is the lack of provision of entrepreneurial spirit and skills to construction students. Bazan et al. (2020) and Korde et al. (2022) highlight the need for university degree programs to evaluate the impact of various factors related to students' entrepreneurial potential. In the field of construction, Jaafar and Abdul Aziz (2008) suggest that entrepreneurship education should be prioritized to produce construction entrepreneurs. The provision of entrepreneurship education to construction students is not only in the form of theories and materials related to the business process but mainly on the required characteristics of entrepreneurs in starting up a construction business. Previous studies have discussed the characteristics and attributes of entrepreneurs, as summarized in Table 1. These characteristics and attributes can be learned and trained by construction students through a CE education.

Table 1 : Characteristics and Attributes of Entrepreneurs

Characteristics	Description	References
Risk taking	Willingness to take risks including financial risks, social risks, technical risks, etc.	Drucker, 2014; Jaafar et al., 2010; Setiawan et al., 2017; Setiawan & Erdogan, 2018
Creativity and imagination	Generating ideas that are original and valuable based on imagination.	Carayannis & Stewart, 2013; Drucker, 2014; Setiawan & Erdogan, 2018
Innovativeness	Ability to create new things and/or provide added values.	Carayannis & Stewart, 2013; Jaafar et al., 2010; Sebastian & Alina, 2014; Setiawan et al., 2017; Setiawan & Erdogan, 2018
Leadership	Ability to influence and guide others with independent and self-confidence, inspirational motivation, charisma, etc.	Ayalp, 2019; Jaafar et al., 2010; Setiawan et al., 2017; Setiawan & Erdogan, 2018
Eager to learn	Willingness to learn by inquisitiveness.	Jaafar et al., 2010
Adaptability	Ability to adjust to new conditions including tolerance for ambiguity and accepting changes.	Carayannis & Stewart, 2013; Drucker, 2014; Jaafar et al., 2010; Setiawan et al., 2017
Need for achievement	Ambition to complete the work smoothly, ambition to expand the scope of business.	Jaafar et al., 2010; Setiawan et al., 2017
Acquisitiveness	Ability to acquire and maintain the possession.	Jaafar et al., 2010
Internal locus of control	Autonomy in planning and managing projects, awareness that the business success depending on hard work.	Carayannis & Stewart, 2013; Jaafar et al., 2010; Setiawan et al., 2017; Setiawan & Erdogan, 2018
Powerful others locus of control	Autonomy for communication and accessing information.	Jaafar et al., 2010; Setiawan & Erdogan, 2018
Organizing	Ability to organize, arrange, and make preparations.	Farhangmehr et al., 2016
Conceptualizing and strategic thinking	Ability to form a concept, to set certain goals.	Carayannis & Stewart, 2013; Drucker, 2014; Farhangmehr et al., 2016
Commitment	Quality of being dedicated for trustworthiness and reliability.	Farhangmehr et al., 2016; Setiawan & Erdogan, 2018
Networking	Action of interacting with other in order to maintain good relationship	Carayannis & Stewart, 2013; Farhangmehr et al., 2016; Setiawan & Erdogan, 2018
Intelligence and analytical abilities	Ability to acquire and apply knowledge and skills, to draw conclusions	Carayannis & Stewart, 2013; Setiawan & Erdogan, 2018; Sartipi, 2020
Experience	Ability to observe events or facts to become source of knowledge and skills	Carayannis & Stewart, 2013
Intuition	Ability to comprehend something.	Carayannis & Stewart, 2013
Integrity, credibility and reputability	Having a strong moral principle which lead to credibility and reputability.	Carayannis & Stewart, 2013
Proactiveness	Acting in advance including for seeking opportunities and managing expected difficulties.	Carayannis & Stewart, 2013; Drucker, 2014; Setiawan et al., 2017; Setiawan & Erdogan, 2018
Persuasiveness	Ability to influence and persuade others.	Carayannis & Stewart, 2013
Problem solver	Ability to solve problems creatively.	Setiawan et al., 2017; Setiawan & Erdogan, 2018
Positioning	Ability to gain a special place or being stand out.	Carayannis & Stewart, 2013; Setiawan & Erdogan, 2018

B. Construction Entrepreneurship Education

Traditionally, construction education is designed to prepare students to be ready to work in the construction industry (Bhattacharjee et al., 2013). This is reflected in Astuti and Martdianty's work (2012) which found that more graduates were more interested in becoming job seekers rather than becoming job creators. However, looking at technological developments and industry demands, expectations of new graduates are changing (Bhattacharjee et al., 2013), and there is a growing opportunity for construction students to become entrepreneurs in the industry (Sampath et al., 2020). Similarly, Silva (2014) shows the potential role of entrepreneurship for construction students and professionals in various areas of construction work, such as claim management, estimation, transportation, and energy.

Construction students, on the other hand, have the possibility to become entrepreneurs because they are equipped with competencies related to managing a construction business such as project management, risk management, value engineering, cost analysis, contract and claim management, time management, financial management, and decision-making (Rostiyanti & Hansen, 2017; Chandramohan et al., 2020; Setiawan et al., 2021; Hansen et al., 2022a; Hansen et al., 2023). However, the reluctance to become an entrepreneur and the stability of job demand are the main barriers to increasing the number of construction entrepreneurs (Shah et al., 2020). According to Shah et al. (2020), the entrepreneurial intention is the most important predictor that determines the entrepreneurial behavior needed by entrepreneurs. For this reason, construction students need to be given an introduction and understanding regarding entrepreneurial thinking and spirits to foster intention and interest toward entrepreneurship.

As a subject, CE is needed to bridge the needs of the construction industry for innovation and performance improvements. In fact, the construction industry is among the least digitalized sectors in the world (Hansen et al., 2022b; Osunsanmi et al., 2018). Its annual productivity growth is stagnating around 1% over the past 20 years (Barbosa et al., 2017). In addition, this sector also faces various issues such as sustainability, globalization, security, and susceptibility (Hansen et al., 2022b). Construction entrepreneurs see this not as an obstacle but as a

business opportunity. Therefore, CE education is essential to train construction students and professionals on strategies to improve the performance of the construction industry and respond to these challenges.

However, the assessment of construction students' entrepreneurial orientation shows a lack of alignment of entrepreneurship studies with construction practices. There are not many educational institutions that provide CE as a teaching subject in their programs. If any, this subject is only equipped with general entrepreneurship principles and construction practices. Consequently, there is a need to develop a CE syllabus that is designed systematically according to the industry's needs. This study highlights the importance of developing a syllabus that can absorb more entrepreneurial knowledge and practices that are relevant to the construction disciplines. Here, CE is defined as the combination of entrepreneurial thinking and spirit that applies to the construction industry. Through learning this subject, it can facilitate the emergence of fresh construction entrepreneurs in the industry (Sampath et al., 2020).

C. Transdisciplinary Learning

The terms multidisciplinary learning, interdisciplinary learning, and transdisciplinary learning are often used interchangeably even though they have fundamental differences (Park & Son, 2010). Multidisciplinary learning refers to a combination of various disciplines as independent and separate components of learning (Garner, 1995). It focuses on developing learning within the traditional discipline (Finch et al., 2021). Interdisciplinary learning provides not only perspectives of different disciplines (multidisciplinary) but also sets up collaborative tasks that the diverse perspectives are discussed and integrated (Feng, 2012). Thus, it creates learner-driven learning in immersive learning contexts (Park & Son, 2010). On the other hand, transdisciplinary learning encourages critical reflection on and liberation of disciplinary boundaries toward learning goals (Finch et al., 2021). Here, academic learning is amplified through collaborative learning with partners from other sectors (Mindt & Rieckmann, 2017; Pratibha et al., 2021) such as construction professionals and entrepreneurs. Thus, students are expected to gain insights into real-world problems and apply their knowledge in a real-life context (Mindt & Rieckmann, 2017).

The fundamental difference among these three lies in the mode and purpose described by Park and Son (2010). The multidisciplinary learning provides learning on various topics from various disciplines, interdisciplinary learning highlights the combination of diverse disciplines to solve a problem, while transdisciplinary learning facilitates collaborative learning through a shared conceptual framework. Hence, transdisciplinary learning is a further step toward interdisciplinary learning (Park & Son, 2010).

In terms of levels of interactivity, multidisciplinary learning mainly focuses on the interactivity between students and content; interdisciplinary learning is learner collaboration driven, whereas transdisciplinary learning is based on learner participation and new knowledge creation. The identity of students becomes different from being a knowledge consumer in multidisciplinary learning, developing into a knowledge collaborator in interdisciplinary learning, and evolving into a knowledge producer in transdisciplinary learning. Likewise, the teacher's role has changed from a knowledge facilitator in multidisciplinary learning to a learning designer in interdisciplinary learning and finally to an interactive learning designer in transdisciplinary learning (Park & Son, 2010).

3. Methodology

A. Research Design

This study aims to investigate CE teaching in a Construction Engineering and Management (CEM) study program. It obtained research ethics approval from Podomoro University, LPPM Project Number: LPPM/RE/002/22. A mixed method approach was adopted to provide a more complete picture of the teaching model. It was conducted in three sequences, as illustrated in Figure 1. The first two sequences are qualitative, while the third sequence is quantitative.

B. Data Collection and Analysis

The data collection process in this study includes interviews and questionnaire surveys. A case study was observed from a CEM program at Podomoro University located in Jakarta, Indonesia. Table 2 presents the profile of the observed CEM program. Interviews were used as a technique to collect qualitative data (Hansen, 2021b) from students who were involved in two reflective discussion forums and construction business plan presentations. Reflective

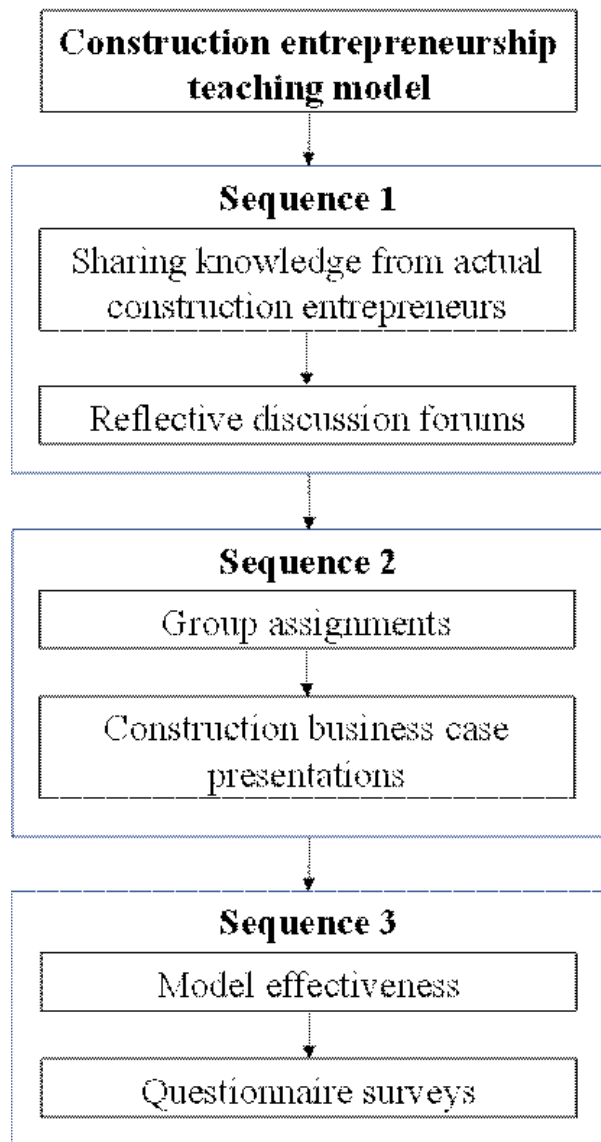


Fig. 1 : Research Design for Construction Entrepreneurship Teaching Investigation

discussion forums were conducted to explore opinions and lessons learned from students in six sharing sessions by actual construction entrepreneurs. The first forum discussed lessons learned from the three sharing sessions held on March 15, 2022, and the second forum discussed the remaining three sharing sessions held on May 10, 2022.

Construction business case presentations were conducted to assess students' skills in developing a construction business idea. At the beginning of the semester students have been grouped into three groups to create a business plan in the construction

industry. The development of this business plan was carried out for 11 weeks and they were able to learn from the experiences of actual construction entrepreneurs in sharing sessions to obtain ideas and/or innovations in the construction sector. On week 15 (May 17, 2022) each group was given a duration of 5-10 minutes to present their construction business pitches. Interviews were conducted to reflect the effectiveness of the method and delivery of this subject.

Next, questionnaire surveys were developed to explore students' perceptions regarding construction entrepreneurship teaching. There are two types of questionnaires served for two different purposes. The first type was a self-evaluative survey addressed to 37 students who had taken the construction entrepreneurship subject. It consists of three parts, namely Part A1, related to the design of construction entrepreneurship teaching (with five questions); Part A2, related to the learning methods (with seven questions); and Part A3, related to the benefits of taking the subject (with five questions). Meanwhile, the second type of questionnaire (Part B) received 67 responses from students who had never taken this subject (both from Podomoro University and other universities) and only focused on the relevance and interest in taking the subject (with five questions). The surveys were distributed to students at the end of the semester (May 12 to June 7, 2022) and received 104 valid responses.

All questions use a 4-point Likert Scale with 1 representing 'strongly disagree', 2 representing 'disagree', 3 representing 'agree', and 4 representing 'strongly agree'. The data were analyzed using descriptive statistics involving means and standard deviations (SD). While the means represent the averages of all responses per question, the sds represent the extent of deviation for that question. A similar evaluative self-assessment survey has been applied to previous studies (Hansen et al., 2022b; Jackson, 2018; Karim et al., 2019).

To determine the internal consistency of the data, a Cronbach's alpha coefficient of reliability must be calculated when using a Likert scale in a questionnaire (Nunnally & Bernstein, 2007). The value of Cronbach's alpha coefficient is between 0 and 1. George and Mallery (2003) suggests that a value of 0.7 is acceptable, 0.8 indicates good internal consistency, while close to 1 is excellent. The results of reliability statistics in this study are presented in

Table 2 : Profile Of Cem Program

Profile	Details
Name	Construction Engineering and Management
Level	Undergraduate
Length of program	Four years
Designed subject	Construction Entrepreneurship
Type	Compulsory unit
Term	Semester 6
Duration	16 weeks

4. Findings and Discussion

A. Transdisciplinary Teaching Model for Construction Entrepreneurship Subject

A discipline is defined as a distinct study area with its own subject matter and content (Davies & Devlin, 2007). This study suggests a transdisciplinary teaching model for CE subjects as a unit to be taught at the CEM program. At Podomoro University, this subject (code CEM3414) was introduced in 2020/2021 and is a unique subject taught in the sixth semester with a weight of two-semester credits (one credit equals 170 minutes of learning per week). The learning outcomes are to:

1. Internalize the spirit of entrepreneurship.
2. Mastering knowledge about entrepreneurship in general and construction entrepreneurship in particular.
3. Able to recognize various aspects of construction entrepreneurship development.
4. Able to demonstrate quality independent and group performance related to construction entrepreneurship topics.

In developing the syllabus, a transdisciplinary learning approach was adopted by fulfilling the six elements of transdisciplinary learning as shown in Table 4. 'Learning methods' refers to the dominant learning method to achieve the fulfilment of TL elements. 'How to' refers to the relevant implementation details of the learning method. Meanwhile, 'Outcome' refers to the expected results from the application of the learning method.

Considering the transdisciplinary learning approach above, Table 5 presents the CE syllabus that has been implemented in the CEM Program of Podomoro University. This syllabus emphasizes more on the aspect of 'thinking and acting like an

entrepreneur' in the context of the construction industry. Hence, the portion of collaborative learning and critical reflection receives great attention. Meanwhile, the problem-based learning (PBL) method was performed on specific topics as a foundation for students' understanding of CE knowledge and practice (Netekal et al., 2022) including: the definition and characteristics of CE, construction technology, construction start-up business and case studies, critical success and failure factors of a construction business, Construction Small-Medium Enterprises (csmes) and family business. The weights in Table 5 are adjustable.

B. Response to the Design of Construction Entrepreneurship Subject

After the above syllabus was implemented, the students' perceptions were collected to evaluate the effectiveness of the transdisciplinary learning approach in CE teaching. The first part of the survey explores students' opinions regarding the design of the CE subject. Table 6 presents statistical results on five questions. The analysis shows that, in general, students have a positive response related to learning design with a mean of above 3 out of a possible value of 4. There is only one point (Q2) where students think they are close to agreeing that their understanding of CE has increased after taking the subject (with a value of 2.95).

A well-designed entrepreneurship education curriculum can significantly improve students' entrepreneurial competencies and interests (Trivedi, 2016). For this reason, entrepreneurship education must be designed with an experiential approach, training, work-related learning, and action-learning (Smith, 2010; Raju et al., 2023). By focusing on the construction industry, this subject is designed to prepare construction students to have the understanding and attitude of entrepreneurs (Gupta et al., 2024) to cultivate entrepreneurship culture in the construction industry (Karthiga & Subhashmi, 2024). Looking at the statistical results above, in general, it can be concluded that the CE subject teaching has been properly designed.

C. Response to the Learning Method

The second part of the Part A survey explores students' opinions regarding the learning methods applied to the CE subject. Table 7 presents statistical results for seven questions. The analysis shows that in

Table 4 :Transdisciplinary Learning Approach Matrix

Elements	Learning Methods	How to	Outcome
Collaborative learning	• Sharing sessions	Encourage the actual entrepreneurs to share their ups and downs in starting their construction business	Effective teamwork and
Critical reflection	• Group assignment • Reflective discussion forums • Group assignment	Promote students working together in developing a construction business plan Explore lessons learned from the experience of actual entrepreneurs Develop a construction business plan by considering lessons learned from the experiences of actual entrepreneurs	networking Critical thinking
Real-life context	• Problem-based learning • Sharing sessions • Group assignment	Present actual data and case studies related to the construction business in Indonesia and the world Share the actual experiences of construction entrepreneurs both successes and failures Focus on business plans that can answer the challenges of actual problems in the Indonesian construction industry	Authentic and relevant learning
Learner participation	• Sharing sessions • Group assignment	Encourage students to lead the sharing sessions Ensure that each member has done their tasks and that everyone understands the business process well	Student-led learning
Knowledge producer	• Reflective discussion forums • Group assignment	Discussions are directed at the discovery of innovative ideas to answer actual problems in the construction industry Develop a construction business plan that is innovative and applicable	New knowledge creation
Interactive learning designer	• Problem-based learning • Sharing sessions • Group assignment • Examination	Encourage students to solve open-ended problems together in the class Invite actual entrepreneurs to share their experiences in starting a construction business Ensure all students participate in the group assignment by sharing tasks and responsibilities Provide interactive examinations that explore students' critical understanding on the subject	Flexible and engaging learning

Table 5 : Recommended Construction Entrepreneurship Syllabus

Week	Topic	Learning Method	Score (%)
1	Introduction to construction entrepreneurship	Problem-based learning method	-
2	Characteristics of construction industry, construction entrepreneurship and technology	Problem-based learning method	-
3	Construction start-up business: how to and case studies	Problem-based learning method	-
4	Construction business experience: architecture consultant	Sharing session	-
5	Construction business experience: contractor	Sharing session	-
6	Construction business experience: real estate developer	Sharing session	-
7	Lessons learned from three sharing sessions	Reflective discussion forum	10
8	Mid-term exam	Examination	30
9	Critical factors influencing the success and failure of construction business	Problem-based learning method	-
10	Construction Small-Medium Enterprises (CSMEs) and family business	Problem-based learning method	-
11	Construction business experience: subcontractor	Sharing session	-
12	Construction business experience: supplier	Sharing session	-
13	Construction business experience: green construction	Sharing session	-
14	Lessons learned from three sharing sessions	Reflective discussion forum	10
15	Construction business case presentation	Group assignment	20
16	Final exam	Examination	30
	Total		100

general students agree that the interactive learning method applied is useful and interesting to follow. This is indicated by all mean values above 3.

Entrepreneurship teaching must be complemented by practical case studies, business simulations,

Table 6 : Students' Perceptions on the Design of Construction Entrepreneurship Subject

No	Questions	Mean	SD
Q1	Construction Entrepreneurship subject is important for me	3.24	0.8
Q2	My understanding of Construction Entrepreneurship increased after taking the subject	2.95	0.74
Q3	Construction Entrepreneurship subject is useful for me	3.19	0.78
Q4	Studying Construction Entrepreneurship subject is relevant to my major	3.16	0.83
Q5	The curriculum design of Construction Entrepreneurship subject has been well structured	3.03	0.73

Table 7 : Students' Perceptions on the Interactive Learning Methods

No	Questions	Mean	SD
Q6	The subject has provided interactive learning methods (including problem-based learning, group assignments, sharing sessions from entrepreneurs, discussion forums, and exams)	3.03	0.91
Q7	The problem-based learning method (by presenting actual data, presentations, and question-answer on construction entrepreneurship problems, etc.) is useful and interesting to follow	3.16	0.83
Q8	The group assignment (by creating construction business plans) is useful and interesting to follow	3	0.94
Q9	The sharing sessions from six actual construction entrepreneurs (different backgrounds) are useful and interesting to follow	3.11	0.89
Q10	The discussion forums (related to lessons learned from six sharing sessions) are useful and interesting to follow	3.03	1
Q11	The exams (in terms of questions, scope, and relevance) are useful and interesting to take	3.11	0.7
Q12	Overall, the Construction Entrepreneurship subject is useful and interesting to follow	3.22	0.87

sharing sessions from entrepreneurs, project teamworks, and the development of a business plan (Henry & Treanor, 2010). Some of these methods were adopted in the CE syllabus by inviting six construction entrepreneurs to sharing sessions, providing problem-based learning accompanied by case study examples, conducting two reflective discussion forums led by student groups, assigning students to make a detailed construction business plan, and carry out examinations that focus on students' critical thinking in providing ideas related to CE. In the observed semester, students succeeded in making a construction business plan with the following topics: Group 1 presents development strategies for a 3D printing construction company, Group 2 aims to provide drone services for on-site monitoring, and Group 3 explores the potential of BIM online training for construction workers.

D. Response to the Benefits of Construction Entrepreneurship Subject

The third part of the survey investigates students' perceptions of the benefits of taking the CE subject. It consists of five questions, and the results of the analysis are presented in Table 8. Based on the statistics, in general, students have a response that is close to agree (with the smallest value of 2.89) that taking this subject is useful in terms of increasing confidence and taking initiatives, opening networking opportunities, training critical and innovative thinking, and the desire to become an entrepreneur after graduating from college. Students also responded agreeing that this subject provides an adequate understanding regarding how to prepare a construction business plan properly.

The statistical results above show that there is room for improvement, especially for students who will take this subject in the future. Observations show

Table 8 : Students' Perceptions on the Benefits From Taking the Subject

No	Questions	Mean	SD
Q13	The subject has increased my confidence to actively ask questions, and take initiatives during the learning process	2.97	0.73
Q14	The subject opens networking opportunities with business actors in the construction sector	2.92	0.89
Q15	The subject trains my critical thinking and innovation within the construction sector	2.97	0.76
Q16	The subject provides an introduction on how to properly prepare a business plan in the construction sector	3	0.75
Q17	I want to be an entrepreneur after graduating from college	2.89	0.81

that perceptions related to these benefits can be further improved if lecturers convey the expected benefits of this subject to students. Related to the benefits of taking this subject, one of the students said as follows.

“At the beginning of the semester, I was still thinking about becoming an employee in a construction company after I graduated. But after taking this subject, I want to try to realize the construction drone business plan that we have made.”

A similar statement was also conveyed by several other students. This shows a change in the paradigm of the students from being a job seeker to being a job creator in the construction industry.

E. Response to the Interest and Relevancy of Construction Entrepreneurship Subject

The second type of questionnaire (Part B) targets students who have never taken the CE subject. It consists of five questions that explore aspects of the level of importance, interest, usefulness, relevance, and expected curriculum design. As shown in Table 9, these five aspects received a positive response from students (with a maximum value of 3.4 out of 4).

The statistics above show the potential for CE subjects to be taught and become an elective subject for other similar study programs. In Indonesia, the CE subject can only be found in the CEM Program of Podomoro University. Other related programs at Podomoro University, such as Architecture and Urban Planning, can make CE subject as their elective subject. Likewise, other universities that have Civil Engineering and other construction-related study programs can also adopt this syllabus to develop the CE subjects on their respective campuses. Alternatively, it is recommended to promote the CE

Table 9 :Non-participating Students' Perceptions

No	Questions	Mean	SD
Q1	Construction Entrepreneurship subject is important for me	3.3	0.67
Q2	Construction Entrepreneurship subject is interesting to me	3	0.76
Q3	Taking Construction Entrepreneurship subject will be useful for me	3.28	0.65
Q4	Taking Construction Entrepreneurship subject is relevant to my major	3.25	0.72
Q5	The curriculum design of Construction Entrepreneurship subject must be properly prepared through interactive learning methods (problem-based learning, group assignments, sharing sessions, discussion forums, and exams)	3.4	0.7

subject by inviting other construction-related study programs from other campuses to participate in this unique subject.

F. Research Implications

The Indonesian construction industry continues to perform poorly (Anif et al., 2021; Rauzana & Usni, 2020). While there have been policy improvements, there is still much that needs to be improved, such as productivity, work quality, and construction innovation. Given the specific nature and challenges of the construction business, efforts are needed to promote the innovation and competitiveness of construction players in Indonesia, which would ultimately improve the performance of the construction industry. Efforts to address this issue can include gaining more experience (Fu et al., 2002), developing corporate entrepreneurship (Peltola, 2012; Setiawan & Erdogan, 2018), and forming effective networks (Keung & Shen, 2017; Patil & Kumbhar, 2022). Ayalp (2019) argues that entrepreneurship is a critical factor in maximizing the performance of the construction industry. However, there are few studies that focus on CE teaching for construction students. This study succeeded in addressing this challenge by providing a CE syllabus and evaluating its implementation in a CEM program.

Learning outcomes are typically defined and/or measured based on a level of dispositions or sub-competencies rather than entire competencies (Mindt & Rieckmann, 2017). Likewise, this study does not intend to apply the principle of entrepreneurship as an achievement for all subjects in the CEM program but rather to the CE subject. This subject aims to broaden students' understanding of their potential to become construction entrepreneurs, explore real-world problems and lessons learned from actual construction entrepreneurs, and attempt to generate construction business ideas and innovations that can address construction business challenges and problems.

The provision of CE as a teaching subject for undergraduates is one of the most effective methods of promoting entrepreneurship (Sampath et al., 2020; Raju & Kumar, 2021). The application of PBL is useful to engage students in discussions of real-world practices (Echempati, 2019). Statistics based on the opinions of students who have taken this subject at Podomoro University show a positive response to the syllabus design, interactive learning methods, and

benefits received by students. In addition, statistics reveal the strong potential for CE subjects to be taught in other construction-related study programs, such as Civil Engineering and Architecture.

The results of this study can be used as a reference in the development of entrepreneurship education in construction-related study programs. The university-government collaboration is the key tool facilitating entrepreneurship growth (Taha et al., 2017). Emmanuel et al. (2020) also suggested the active role of the government in providing more initiatives to support and equip construction graduates with relevant entrepreneurial skills in collaboration with educational institutions. Therefore, this study encourages the active role of the government to adopt the CE teaching that has been implemented by the CEM program of Podomoro University.

The limitation of this research lies in the survey design, which is cross-sectional (administered at just one point in time) rather than a longitudinal survey, which might provide further light on the effectiveness of CE teaching. Therefore, subsequent subject delivery needs to be analyzed to evaluate its effectiveness and potential for future development. Further studies can also focus on the harmonization of the laws to support entrepreneurship education in the construction industry. This is important given the lack of studies on the role of government in regulating construction entrepreneurship and its education.

5. Conclusions

This study has described the effectiveness and success of implementing transdisciplinary learning on CE subjects in a CEM program. The results of the case study suggest that the application of transdisciplinary learning is very applicable and useful for students taking the CE subject. The CE syllabus designed has met the learning outcomes and the statistics show student agreement regarding the syllabus design, interactive learning methods, and the benefits of taking this subject. In addition, the statistics also show the interest of students from other construction-related programs to take the CE subject.

This study contributes by promoting CE as a teaching subject in construction-related disciplines. The findings can serve as a reference model for the development of the CE module in other universities, both in Indonesia and on a global scale. This study provides more insights to construction lecturers on

how entrepreneurship should be incorporated into construction-related disciplines.

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