Promoting Successful Projects in a Software Engineering Capstone Course

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Abstract. *Software capstone projects are successful when students achieve meaningful learning outcomes and clients obtain valuable results. For more than a decade, we have delivered a capstone course involving diverse external clients and domains, producing mostly successful projects; however, some initiatives have still fallen short. This study seeks to identify factors that foster or hinder project success in order to support instructors in structuring course dynamics and selecting appropriate projects and clients. We analyzed 18 software projects from the Spring 2024 term. At course completion, surveys were administered to both clients and student teams to evaluate technical competence, domain knowledge, time commitment, and collaborative attitude of each other. Five months later, follow-up semi-structured interviews with clients explored product value and retrospective perceptions. Survey and interview data were then cross-analyzed. Most projects were rated as successful across survey dimensions, with both groups highlighting commitment as a central factor. In less successful cases, students pointed to low client involvement or limited domain knowledge as key obstacles. At interview time, nearly all products were in use, although most required additional refinement. Even clients from less favorably rated projects generally expressed willingness to participate again, emphasizing students' technical quality and hiring potential. Maximizing capstone success requires selecting clients who propose well-scoped, engaging projects and who understand the need for adaptive collaboration. Providing students with access to domain experts and end-users further strengthens alignment with business needs, improving both learning outcomes and practical value for clients.*

1. Introduction

Modern software developers require not only strong technical expertise but also well-developed soft skills, such as teamwork, leadership, and interaction capabilities with the counterpart. For this reason, most computer science programs include both theoretical courses and project-based learning (PBL) experiences that require the integration of technical and interpersonal competencies. In introductory PBL courses, clients are typically the students themselves or course instructors. In contrast, capstone courses are more advanced PBL courses, often involving external clients from industry, providing students with a more authentic experience [AAAI 2024][Faizi and Umar 2021]. Capstone courses can take the form of community service projects, offering a mutually beneficial, win–win experience. In these scenarios, industry clients often value the foundational knowledge

that students are expected to have acquired by the end of their studies and students appreciate the opportunity to engage with real-world projects that expose them to practical challenges and emerging technological possibilities [Garousi et al. 2019][Simha et al. 2024].

In this context, a successful software development project is one in which a high-quality development team delivers a software product that is perceived by the client as highly valuable. According to Hoegl et al. [Hoegl and Gemuenden 2001], the behavior of these teams makes explicit key attributes such as strong communication, high coordination, balanced contributions, mutual support, sustained effort, and team cohesion. A valuable software product is one that fulfills the specified requirements, exhibits robustness, and provides measurable value to the client organization. On the other hand, research has shown that successful industrial projects require engaged clients who have a strong understanding of the business problem being addressed and who maintain active involvement throughout the development process [Baroudi et al. 1986].

Although external clients generally have a clear interest in obtaining high-quality outcomes from their participation in a capstone course, project results are not always successful. For instance, clients may disengage before the project is completed due to various factors—such as a lack of confidence in the students' ability to deliver a valuable product or limited availability, which may lead them to view their involvement as a mere favor [Matturro et al. 2018]. Clients can also have expectations that exceed what can realistically be accomplished within the course time-frame.

The goal of this paper is to better understand the factors that contribute to the success of capstone software projects, considering both the educational outcomes for students and the value delivered to external clients. In particular, we examine how students and clients perceive project success and how the project experience relates to the perceived usefulness and adoption of the resulting software artifacts. To this end, we analyze 18 projects conducted during a single academic term, combining post-course surveys with follow-up client interviews conducted five months after course completion. The analysis reveals that student and client perceptions of project success are largely aligned in most projects, both parties reported highly successful experiences. When discrepancies arose, they were primarily associated with differences in perceived commitment and attitude. Students consistently emphasized the importance of client domain knowledge, while clients placed greater weight on students' technical competence, with commitment emerging as a critical success factor for both groups. Longitudinal evidence shows that product value is often realized over time rather than immediately at course completion. Although few projects were deployed exactly as delivered, many were later integrated into larger systems or deployed after additional development, with delays largely attributed to limited client availability rather than deficiencies in the student work. Importantly, nearly all clients, regardless of deployment status, expressed satisfaction with the collaboration, interest in participating again, and willingness to hire students from the course.

Taken together, these findings highlight that capstone project success perception depends not only on technical outcomes, but also on sustained client engagement, realistic expectations regarding deployment timelines, and careful client selection. They suggest that instructors can improve both learning experiences and product impact by prioritizing motivated clients with sufficient domain expertise, setting clear collaboration expectations, and explicitly supporting early and continuous client involvement.

2. Related work

2.1. Project-based and service learning

Software development is inherently a collaborative activity, so computer science programs often incorporate team-based software development courses [AAAI 2024]. These courses typically fall into two categories: problem-based learning and project-based learning. Problem-based learning is a student-centered teaching method where students collaborate to solve real-world problems. It emphasizes self-directed learning, encouraging students to take ownership of their learning process. In contrast, project-based learning often involves defining a problem to address and focuses on creating a tangible product as a solution. While problem-based aims to develop competencies for collaborative problem-solving, project-based emphasizes integrating teamwork activities with technical knowledge to deliver practical outcomes. Therefore, project-based learning courses are generally more appropriate for advanced students [Broman 2010][1].

Software engineering capstone courses serve as ending experiences where students apply the knowledge and skills they have gained throughout their program [Bastarrica et al. 2017]. Here students gain firsthand experience in identifying factors that contribute to success and understanding what may hinder progress, preparing them for real-world challenges. However, there is not much published work about specific experiences between capstone courses that include industry clients [Cico et al. 2021].

Service Learning is an teaching and learning approach that combines academic instruction with community service, allowing students to apply their knowledge to real-world challenges [Sanderson and Vollmar 2000]. The goal is to create a mutually beneficial experience: students gain meaningful, hands-on learning, while external organizations benefit from the solutions or products developed during the course. It has been reported that both, computer science students and the instructional staff value the collaboration with real industrial clients [Khakurel and Porras 2020],[Spichkova 2019] and so do clients [Isomöttönen and Kärkkäinen 2008],[Paasivaara et al. 2019]. Additionally, companies sometimes participate in these initiatives with the intention of identifying and recruiting potential employees who have demonstrated relevant skills and experience.

2.2. Impact of the client in the projects success

Some research focus on how customer quality affect industrial software development but only a few in academic settings. Nasir and Sahibuddin [Nasir and Sahibuddin 2011] conducted a systematic review on the factors affecting software projects success. They found that 94% of the published articles focus on non-technical factors while only 6% refer to technical factors. The most critical factors found were: clear requirements, realistic estimation of time and budget, a competent project manager. Some of these elements were included as part of our evaluation instrument: technical knowledge (technical factors), domain knowledge (requirements) and client quality (competent project manager). We did not considered time and budget since our setting is a capstone course where these issues are fixed. However, we found that this time constraint was a key determinant of project success, as it directly limits the size and complexity of the projects that can be effectively addressed within a 15-week time frame.

[1] In this work we will use PBL as an acronym for project-based learning.

Jørgensen et al. [Jørgensen et al. 2017] report on the outcomes of software development projects based on different types of contracts. Their findings indicate that projects operating under fixed-scope contracts carry a higher risk of failure. Conversely, factors such as careful client selection, active client involvement, the use of agile practices, and a focus on delivering added value significantly increase the likelihood of project success. These findings are consistent with our own results.

Matturro et al. [Matturro et al. 2018] examined the role of product owners (PO) from the perspective of practitioners in software companies, focusing on how these individuals should be selected. Similarly, our approach gathers students' perceptions of their clients, who take on the role of outsourced PO within the context of the capstone projects. They found that two of the main desirable characteristics are: previous experience in this role and knowledge of the business that would benefit with the project. Unger-Windeler et al. [Unger-Windeler et al. 2019] highlight several open challenges about the impact of the PO role on project success, largely due to limited empirical evidence across diverse contexts. In particular, requirements engineering practices are often overlooked: although POs are formally responsible for requirements, there is little research on how they actually carry out these activities or collaborate with others. Leadership and management responsibilities are likewise not clearly defined. In this work, we contribute empirical evidence by analyzing PO-related requirements engineering (through domain knowledge) and leadership and management dimensions (through attitude and commitment).

Binboga et al. [Binboga and Altin Gumussoy 2024] recently investigated factors influencing software development project success through a survey and interviews with practitioners in Turkey. Their findings highlighted that customer-related factors are among the most critical determinants of project success, aligning with the focus of our research. Furthermore, they defined success in terms of process efficiency, product quality, and stakeholder satisfaction, which also aligns with our view of success.

Marriska [Marriska 2015] examines how student projects are affected when working with internal versus external clients, as is the case of our capstone course. Both scenarios present challenges related to project management, requirements engineering, teamwork, and technology. However, projects involving real clients introduce additional challenges, such as managing client commitment and dealing with unclear requirements. Furthermore, students may experience concerns about creativity limitations, lack of control over requirements, and pressure to deliver high-quality outcomes. To enhance the learning experience, they recommend instructors to carefully select and prepare clients, ensuring they contribute positively to the project's success.

Having difficulties when working with external clients has been already identified in several studies. Khemlevsky et al. [Khmelevsky 2016] report an experience where capstone courses fail due to client unavailability: they did not show up for scheduled meetings and this resulted in low morale for students. Other authors report similar experiences and stress the relevance of finding committed clients to ensure a good experience for the students [Anslow and Maurer 2015], [Lundqvist et al. 2019]. In our course, companies are required to pay a modest fee, which is fully allocated to covering student expenses and compensating team tutors. This approach aims to mitigate the risk of company disengagement, as the financial commitment serves as an indicator of genuine interest.

3. Methodology

We conducted an exploratory study in the capstone course of the Computer Science program at the University of Chile[2] to gather information about project outcomes from both client and student perspectives. This was followed by a confirmatory study aimed at gaining deeper insights into the specific characteristics that contribute to a project's success.

This course is the third software engineering course in the curriculum and is typically taken during the 10th semester. It spans 15 weeks and follows an incremental development approach organized into three iterations. Students work in teams of six to eight members, each devoting approximately 16 hours per week to the project. Their goal is to develop a real-world application for an external organization, which designates at least one representative to act as client. Clients are expected to dedicate a minimum of eight hours per week to interacting with the student team and addressing project-related tasks. Communication may occur through face-to-face meetings, work sessions, email, or dedicated online groups created for this purpose.

Historically, most projects have been completed successfully; however, a few have encountered some difficulties, and a small number have ultimately failed.

3.1. Research questions

Our aim is to identify the characteristics that contribute to the success of the capstone course for all stakeholders involved. This information will enable instructors to refine the course design and make more informed decisions when selecting clients and projects.

A first study intends to assess the success of the project experience. To this end we state the following research question:

RQ1: How do students and clients evaluate the project experience success?

The research question aims to compare the client's assessment of the student team with the team's evaluation of the client. A project experience is considered completely successful when both parties share a positive evaluation.

The second study aims to deepen our understanding of the characteristics that distinguish successful projects from those that were less effective. To guide this analysis, we pose the following research question:

RQ2: How do clients evaluate the results of the project?

This question aims to gather information about clients perception of the success of the project with respect to the results they obtained considering both, the product obtained and the experience.

We conducted a survey for the first study and a series of interviews for the second.

3.2. Student and client experience evaluation

Inspired in UK-Spec [Council 2020], we defined an instrument considering four key dimensions for the evaluation: technical knowledge, domain knowledge, time commitment,

[2]Ranked first in Chile and seventh in all of Latin America (https://edurank.org/cs/la/)

and attitude. Each dimension was measured using a seven-point Likert scale: (7) excellent, (6) very good, (5) good, (4) neutral, (3) poor, (2) very poor, and (1) awful. We also ask for a general evaluation using the same scale as well as optional comments.

The dimensions used to define quality have slightly different meanings for students and clients. For students, technical knowledge refers to the extent to which the client understands the technology used. Conversely, for clients, technical knowledge reflects how well students have mastered or how quickly they can learn the technology necessary for the project. A client with extensive domain knowledge helps students understand the underlying rationale for the project, providing clarity on the "why" that drives it. Similarly, students with strong expertise can quickly grasp this rationale, ensuring a smoother alignment with the project's objectives. The students' time commitment reflects the client's perception of how efficiently and effectively students dedicate their time to the project. Similarly, the clients' time commitment demonstrates their active involvement in the project's success, enabling students to make faster progress by promptly addressing questions and issues. Lastly, attitude refers to how students feel they are treated by the client, e.g. whether the client attends meetings regularly and treats them respectfully. For clients, this dimension has practically the same meaning.

The course included 133 students divided into 18 project teams, each consisting of 7 or 8 students, as described in the students' columns of Table 1. Every project had a different client who represented the respective organization.

The survey was issued through Google Forms to both clients and students. As part of the course participation agreement, clients commit to completing this evaluation and attending the final project presentation. Students were required to indicate the project in which they participated, but no additional personal identifying information was collected. They were also asked to provide informed consent for the use of their responses for research purposes. The survey was conducted at the end of the semester, after the projects had concluded but before students received their grades. Participation in the study was voluntary for students. Although it was a requirement, two clients failed to submit their responses, and another two did not attend the final presentations as shown in Table 1.

3.3. Project success evaluation

A project is successful from the clients' perspective when it meets their expectations. In this context, success is understood along three main dimensions: the perceived value of the delivered product, the overall experience of participating in the project, and the opportunity to identify and potentially recruit highly proficient students.

To evaluate project outcomes, we conducted individual semi-structured interviews with clients five months after project completion. During these interviews, clients were asked whether the developed product was being used, if they would consider submitting a new project, and whether they would be willing to hire any of the students. In addition, they were encouraged to provide any further comments they deemed relevant.

In April 2025, all clients of the projects involved in the study were invited to participate in individual, online semi-structured interviews. 14 agreed to take part in this phase of the study, as indicated in the last column of Table 1. Each interview began by requesting the client's consent to record the session; all participants agreed. We introduced the interview with the following statement: "With the aim of improving the course

Table 1. Student and client participation per project

Team	Students			Clients			
	Team size	Answers	%	Previous	Grade	Attendance	Answer
Agendas médicas	7	5	71		✓	✓	✗
Análisis RAM	8	5	63		✓	✓	✓
Supervivencia	7	3	43	✓	✓	✓	✓
BPMSNoCode	7	5	71	✓	✓	✓	✓
Back office web	8	4	50		✓	✓	✓
DataB	7	3	43		✓	✓	✓
EPEC	8	6	75	✓	✓	✓	✓
Gestión de clientes	7	5	71		✓	✓	✓
Índices	7	5	71	✓	✓	✓	✓
Salud SpA	7	4	57		✓	✓	✗
Modelos mineros	7	6	86		✓	✓	✓
MyHub	8	4	50		✗	✓	✓
Drones	8	5	63		✓	✗	✗
PACES	8	7	88		✓	✓	✓
Portal del paciente	8	6	75		✓	✓	✓
Roblox	7	5	71		✓	✓	✗
Gim	7	4	57		✗	✓	✓
UMCE	7	5	71	✓	✓	✗	✓
Total	133	89	67	27%	89%	89%	78%

and maximizing the benefits for both students and clients, we are conducting research on perceptions from both groups." The interview then proceeded according to the defined protocol. Each session lasted between 5 and 12 minutes.

4. Student and client experience evaluation

Using the collected data, we calculated the survey's Cronbach's alpha, obtaining a value of 0.87, indicating a high level of reliability. Teams' responses were systematically uniform in all dimensions. Therefore, we just report on the median value for each dimension.

4.1. Completely successful projects

Figure 1 shows the results for the 8 perfect or nearly perfect projects [3]. We also included MyHub in this group because even though the client did not provide the required grades, students' evaluations were consistently high as well as they provided positive comments. Also, as stated in Table 1, all these clients attended the final presentation.

Students' comments for these clients were consistently positive.

Modelos mineros: "Pleasantly surprised by the client, he fostered a pleasant work environment, provided excellent feedback and recommendations, and asked us to perform challenging tasks with realistic expectations."

BPMSNoCode: "He clearly understands the problem and how to solve it, he also has the necessary knowledge to understand our approaches and problems during our work."

MyHub: "They are the best we could have had, very attentive to everything and willing to contribute."

However, there are also some minor complaints mainly related to evaluations.

Agendas médicas: "Very good. The only downside is that sometimes the score doesn't match the feedback."

[3] Values are coded to ease interpretation: 1 and 2 in yellow, 3, 4, and 5 in orange, and 6 and 7 in blue.

Agendas médicas			
	Team	Client	Difference
Technical	7	6	1
Domain	6	6	0
Commitment	7	7	0
Attitude	7	7	0
General	7	6	1

Supervivencia			
	Team	Client	Difference
Technical	7	7	0
Domain	6	7	-1
Commitment	6	7	-1
Attitude	7	7	0
General	6	7	-1

Gestión de clientes			
	Team	Client	Difference
Technical	7	6	1
Domain	5	7	-2
Commitment	7	7	0
Attitude	6	7	-1
General	6	7	-1

Análisis RAM			
	Team	Client	Difference
Technical	7	7	0
Domain	7	7	0
Commitment	7	7	0
Attitude	7	7	0
General	7	7	0

Modelos mineros			
	Team	Client	Difference
Technical	7	7	0
Domain	7	7	0
Commitment	7	7	0
Attitude	7	7	0
General	7	7	0

MyHub			
	Team	Client	Difference
Technical	7		
Domain	7		
Commitment	7		
Attitude	7		
General	7		

Portal del paciente			
	Team	Client	Difference
Technical	7	7	0
Domain	7	7	0
Commitment	7	7	0
Attitude	7	7	0
General	7	7	0

BPMSNoCode			
	Team	Client	Difference
Technical	7	7	0
Domain	7	7	0
Commitment	7	7	0
Attitude	7	7	0
General	7	7	0

Figure 1. Completely successful projects

EPEC			
	Team	Client	Difference
Technical	3	3	0
Domain	6	3	3
Commitment	5	3	2
Attitude	5	3	2
General	5	3	2

Gim			
	Team	Client	Difference
Technical	2,5		
Domain	3,5		
Commitment	5		
Attitude	5		
General	4		

UMCE			
	Team	Client	Difference
Technical	5	5	0
Domain	4	6	-2
Commitment	3	5	-2
Attitude	5	5	0
General	3	4	-1

Figure 2. Consistently bad evaluations

Gestión de clientes: "Very good disposition to work but lack of positive feedback (especially in public) which affected the team's motivation."

Some of the comments provided by the clients are:

Agendas médicas: "The team showed significant progress throughout the project, demonstrating improvements with each delivery, closely related to their commitment and growing understanding of the operation. Work organization was efficient, and the team responded positively to feedback, effectively aligning with their counterpart's expectations. Their technical knowledge base and theoretical foundations was notable, reflected in their ability to adapt to unfamiliar technologies and develop high-quality software solutions."

BPMSNoCode: "Very good team always willing to solve problems. Good organization."

Students value client commitment and domain knowledge, likely because these attributes were the least expected and thus more salient when present. In contrast, clients emphasize students' technical competence and commitment as their main strengths.

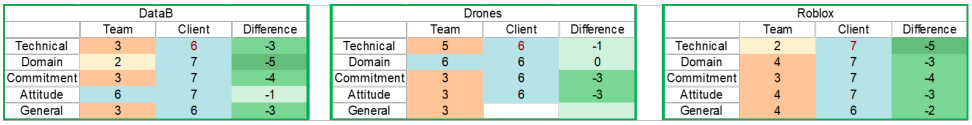
4.2. Perfect match unsuccessful project

Even though not awful, three projects got low evaluations for both, students and clients as shown in Figure 2.

Some of the comments provided by the students are as follows:

UMCE: "We usually asked them for meetings to review the project's progress, but they didn't seem to care."

EPEC: "The process could have been more efficient if they had coordinated the meetings early on. It wasn't until midway through Milestone 2 that we learned that there were



DataB

	Team	Client	Difference
Technical	3	6	-3
Domain	2	7	-5
Commitment	3	7	-4
Attitude	6	7	-1
General	3	6	-3

Drones

	Team	Client	Difference
Technical	5	6	-1
Domain	6	6	0
Commitment	3	6	-3
Attitude	3	6	-3
General	3		

Roblox

	Team	Client	Difference
Technical	2	7	-5
Domain	4	7	-3
Commitment	3	7	-4
Attitude	4	7	-3
General	4	6	-2

Figure 3. Students' low perception

templates for these projects, a technical manager, and even designers available."

Gim: "The lack of understanding of the problem was evident in the multiple meetings to gather requirements, in addition to a disconnect between our counterpart and the target users (their own employees)."

The comments indicate that students perceived limited client engagement in these projects. Notably, the UMCE client did not attend the final presentation, and the Gim client did not respond to the survey. Some of the clients' comments are:

EPEC: "The tool delivered was not functional and did not align with either the original request or the observations raised during the tool's development. It is important to note that the development period was extremely limited, lasting no more than two weeks, with neither possibility of truly testing the tool, nor incorporating important observations. So, it was a blind effort by the student team. Without feedback on what they were doing or working on the tool, we were unable to align the development with our requirements."

UMCE: "The team had a good start in the initial phase of the project, showing commitment and dedication. However, they failed to achieve the objectives of the project proposal. At the code level, significant areas for improvement were identified: repetitive code, lack of alignment with standards, and inconsistencies in component definitions. While the team's efforts are recognized, we will need to conduct a thorough review of the work to align the code with the required standards and optimize performance."

Both student and client responses indicate that insufficient timely commitment and incomplete domain understanding on either side contributed to project failure.

4.3. Students' lower perception than clients

Another category of projects is that where students gave low evaluations of their clients, yet the clients provided high ratings for the students as depicted in Figure 3. There are not only differences, but these are quite large. It is worth noting that the client from Drones neither attended the final presentation nor provided comments.

Students provided some comments about their clients that support the evaluations:

Drones: "He shows no interest in the project, it also seems as if he is taking us for granted (the treatment would be very different if we were a real company and not students)."

DataB: "They had no idea what the project was about, they were never flexible with meeting times, they just left everything to the IT guy who eventually went on vacation, they just asked for more and more requirements without taking our time into account."

On the other hand, clients also provided some comments:

DataB: "Very fluid and regular communication. Willingness to learn and creative contributions to the project. Unfortunately, the group grew smaller and smaller."

PACES			
	Team	Client	Difference
Technical	5	7	-2
Domain	3	7	-4
Commitment	6	7	-1
Attitude	7	7	0
General	5	7	-2

Salud SpA			
	Team	Client	Difference
Technical	6	7	-1
Domain	6,5	6	0,5
Commitment	6,5	6	0,5
Attitude	4	7	-3
General	5	7	-2

Índices			
	Team	Client	Difference
Technical	7	7	0
Domain	6	5	1
Commitment	6	7	-1
Attitude	2	6	-4
General	2	6	-4

Figure 4. Students' satisfaction affected by attitude

Backoffice web			
	Team	Client	Difference
Technical	7	4	3
Domain	7	5	2
Commitment	7	4	3
Attitude	6,5	5	1,5
General	7	3	4

Figure 5. Client's low perception

Roblox: "Very good students, excellent work."

In this type of projects, students clearly perceive very low commitment and poor attitude from clients. This perception aligns with the clients' behavior, where they provide high ratings but show little genuine interest in the project.

4.4. Client's attitude influence satisfaction

There is still other category that could have been classified as one of the previous ones, but paying attention to the comments, they suggest a different scenario (see Figure 4).

In all three cases, client evaluations were consistently high; however, students expressed varied opinions across different dimensions. Notably, in Salud SpA and Índices, technical and domain knowledge as well as commitment received the highest ratings. However, poor attitude resulted in a lower overall perception of the client. In contrast, in PACES, technical and domain knowledge were rated low, but strong commitment and attitude appeared to boost team morale, leading to a more favorable overall perception. These observations are supported by the comments provided.

PACES: "It's a great client, but has little knowledge about technical issues. Especially issues that are part of the institution and beyond the control of the development team."

Índices: "The relationship with the client was bad from the beginning. For example, we had to accept daily meetings against our decision, but this did not yield good results: the atmosphere remained tense, and the pressure from the client was constant. The meetings frequently stopped being constructive and became a series of reproaches. Our efforts were minimized, our work pace was criticized, and they even insisted that certain linear algebra tasks were "easy", without taking into account the actual complexity or the time required. The most surprising thing was that, during the final presentation, the client completely changed his position, praising our work and publicly acknowledging the difficulty of the project, even admitting that others had failed where we had made progress."

4.5. Clients' lower perception than students

There was only one project where students evaluated their client very high, but not otherwise as shown in Figure 5.

One of the students' comment is as follows: "The fact that the client is an alumnus of the same university helps a lot, as he knows how much to demand and how to help the project move forward quickly." However, the client's opinion was not that good: "It was a

Table 2. Project success perception

Experience	Project	In use	Participate again	Hire
Completely successful	Modelos mineros	Not yet	Yes	Yes
	BPMSNoCode	Yes	Yes	Yes
	Gestión de clientes	Not yet	When we have a project	Only some
	Supervivencia	Yes	Yes	Already did
	Analisis RAM	In part	Yes	Yes
	MyHub	Yes	Yes	Already did
	Salud SpA	Not yet	Yes	Yes
Consistent bad evaluations	Gim	No	No	Only some
	EPEC	No	Yes	No
	UMCE	Yes	Yes	Only some
Bad client	DataB	Yes	Yes	Yes
Relevant attitude	PACES	Yes	Yes	Already did
	Indices	No	Only with a clearer project	No
Bad students	Backoffice web	No	No	Only some

mixed experience. I think that for eight people, the work done was too poor. There were organizational issues, and strategies like mob/pair programming were misused."

This client was highly qualified, maintained a positive attitude toward the team, and did not express dissatisfaction openly. Although the students were pleased with their project, the outcome was not considered successful.

5. Project success evaluation

Table 2 summarizes the results of the interviews. In order to facilitate analysis, we organized them into the same groups according to the results in the experience survey.

5.1. Completely successful projects

Five months after project completion, these clients' interview responses indicate sustained satisfaction. All of them expressed willingness to hire students from the course, and several have already done so. All but one client also indicated interest in participating in the course again. In all cases, as part of the comments, client highlight students' willingness to understand the business problem beyond the software they were asked to develop.

However, only about half of the developed products are currently in operational use, and most deployments required additional client effort after delivery. Clients reported several distinct reasons for non-deployment:

Modelos mineros: integration with the client's complex platform is still in progress.
Salud SpA: deployment is pending legal review because the system handles health data; the client has not yet had time to complete this process.
Gestión de clientes: an intern was hired to complete deployment; the system is not yet ready but is expected to be soon.

These findings suggest that, while project outcomes are perceived as successful, complete transition to production often requires post-delivery work and organizational or legal steps that should be anticipated in future course projects.

5.2. Consistent bad evaluations

All clients who were initially dissatisfied with their project results agreed to be interviewed; at the time of the interviews only UMCE had the product in use. Clients reported

not all students were fully engaged, and they would consider hiring only those individuals. UMCE completed the extra work needed to finish and deploy the software despite noting that, in some cases, technical quality was insufficient. By contrast, EPEC judged the delivered product too limited and indicated a preference to rebuild it from scratch. Gim warrants particular attention: they report that the product is not in use and that they do not wish to participate in the course again. Their comments summarize the issue: "We proposed many things and expectations were high. In the end, most items remained incomplete, and we are still deciding if the system is worth the remaining investment."

Across these projects, students reported that some clients did not allocate sufficient time for meetings and timely validation. Taken together, the findings indicate that when client expectations are high, sustained client time commitment is critical; without it, project outcomes are unlikely to reach production readiness.

5.3. Student's low perception

Two of the clients in this group did not respond to the interview request, not even to decline participation. The only client who agreed to be interviewed was the one who had received a slightly more positive evaluation from students regarding their attitude. This client reported high satisfaction with both the students' performance and the course organization, although he noted that the delivered product required substantial extra work before it could be deployed. Nevertheless, he emphasized the high quality of the work obtained at a very reasonable cost. While we assume that "cost" primarily referred to financial expenditure, it is likely that the actual time investment from the client was minimal, which may in turn have influenced students' perception of the client's value.

5.4. Students satisfaction affected by attitude

These results highlight two contrasting cases. The Indices client was perceived as highly competent in technical and domain aspects but low in attitude. In contrast, the PACES client received only moderate ratings in technical and domain expertise but very high in attitude and commitment, leading to substantially higher student satisfaction.

The PACES clients declared that the delivered product required substantial extra work after the course to reach deployment. They hired two team members as interns to complete it and expressed high satisfaction with the results. They also said that the experience improved their own ability to formulate future project proposals and stated her intention to submit a new project soon. Conversely, the Indices client described the outcome as a successful proof of concept useful for validating requirements, although the system would be rebuilt from scratch. He recognized that the project had been more complex than anticipated and noted that future proposals should be more clearly defined.

In both cases, the findings suggest that a 15-week period is often insufficient for full project completion when scope is unclear; however, client engagement and attitude appear to significantly influence students' overall experience and satisfaction.

5.5. Client's low perception

This final case is particularly noteworthy. The client, a former student of the same university who had taken the course several years earlier, reported high initial expectations for the project but ultimately expressed limited satisfaction with the outcome. He expressed

that the students appeared to complete their work in only a fraction of the time available and perceived little sense of pressure or urgency in their effort. Nevertheless, similarly to the Indices client, he acknowledged that the software delivered functioned as a proof of concept that he later used as the basis for rebuilding the system from scratch himself, a process he reported took only a few weeks.

Students evaluated this client very positively. This suggests that he may not have openly expressed his dissatisfaction with what he perceived as limited progress. It is plausible that his generally supportive attitude contributed to students' favorable perception, and that more explicit constructive feedback might have been well received.

6. Discussion

The main goal of this study is to identify the characteristics that contribute to a successful capstone course, defined as both a positive experience for participants and the development of a high-quality product.

6.1. Experience and product evaluation

Results indicate that the least successful situations occurred when clients exhibited low commitment and limited domain knowledge. Under these conditions, students felt disoriented and poorly supported, which in turn reduced their motivation. In contrast, projects perceived as successful were strongly associated with positive client attitudes and sustained engagement. Notably, high levels of technical or domain competence alone did not guarantee successful outcomes. When clients failed to communicate concerns in a constructive manner, the effectiveness of the collaboration was low despite their expertise.

Regarding RQ1, the findings show that perceptions of success are not necessarily shared between students and clients; nevertheless, specific client characteristics play a decisive role in shaping whether the experience is ultimately viewed as successful.

Concerning RQ2, clients generally rated students highly in terms of commitment, technical quality, and ability to align solutions with business needs, and most expressed willingness to participate in the course again. However, in nearly all cases the delivered projects required substantial additional effort before reaching deployment readiness.

6.2. Threats to validity

Although the dimensions included in the survey and the interview instruments are grounded in scientific literature on project quality and successful capstone courses, the selection of these dimensions may still reflect our prior experience, potentially introducing bias. Nevertheless, the instrument effectively captures information for these dimensions, and additional ones could be incorporated in future research.

An external threat to validity relates to the project setting: the participants education, the course organization, and the types of projects selected. Furthermore, since this is part of a regular course, students were not able to opt out of the project if they were dissatisfied so results may not generalize to industrial software development teams.

All empirical research in software engineering could benefit from replication. While this is true for our study as well, we believe our dataset is sufficiently large for obtaining valuable insights. We intend to make use of the results to adjust the course instead of replicating the same experience.

7. Conclusion

Capstone courses in software engineering constitute a well-established PBL setting where students engage with real clients and real problems under academic supervision. Here, students discover that successful software development goes beyond programming and requires sustained collaboration with external stakeholders, whose availability, knowledge, and working style significantly shape project outcomes.

This study examined which client characteristics are most strongly associated with positive student experiences and project success. Our results show that students primarily value client commitment, especially when accompanied by strong domain knowledge and a constructive attitude. In contrast, clients' technical knowledge is seldom mentioned by students as a key contributor to success. From the client perspective, however, students' technical competence and commitment are viewed as the most critical team qualities. These complementary perspectives highlight that project success in capstone settings depends on balanced engagement and clearly understood roles on both sides.

The findings suggest several practical implications for course design and project selection. Clients should be clearly informed about course constraints—such as limited duration, student availability, and the focus on delivering a valuable product regardless of its size—so that expectations about scope and progress remain realistic. Early and sustained client involvement is essential, particularly to support a deep understanding of the business domain and to reduce scope uncertainty. Whenever possible, client representatives should have sufficient domain expertise; relying only on technical counterparts tends to reduce perceived product value. When project goals are initially unclear, stakeholders should recognize that additional time will be required to refine scope, which may reduce final functionality without implying poor student performance. Students, in turn, should prioritize incremental value delivery through well-defined minimal solutions.

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