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Jumping into deep waters: The impact of industry experience on student motivation

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Abstract

This study examines the motivational changes of undergraduate students participating in a practical course designed to address the challenge of aligning academic training with industry needs. The study spanned two iterations of the course. During the first iteration, qualitative interviews were conducted to assess changes in student motivation throughout the practical course. In the second iteration, a motivation questionnaire was administered at three points: before, during, and after course completion. The results indicate a general decrease in student motivation during the course, followed by a partial recovery towards the end. This fluctuation highlights the need for continuous support and realistic feedback to maintain student engagement and motivation. This study contributes to the expanding body of research on how practical, industry-focused courses influence student motivation. By incorporating real-world contexts and challenges, this type of course can greatly enrich learning experiences and better prepare students for professional settings. However, one should carefully design these courses and implement effective mechanisms to maintain and foster student motivation throughout the course duration.

Keywords: industrial setting, motivation, practical course, soft skills, teamwork, undergraduates

INTRODUCTION

It has been a long time since the industry and academy acknowledged the significance of soft skills for information systems (IS) professionals. Soft skills significantly impact learning, team performance, client relations, and business context awareness (Adelakun-Adeyemo, 2021; Jiracheewewong, 2022; St. Louis et al., 2021; Stevens & Norman, 2016). Some employers consider the ability to interact, communicate, manage time, negotiate, and solve problems more important than technical skills for their junior position candidates (Jones et al., 2018). However, the gap between the skills and knowledge gained within undergraduate studies and industry needs and expectations is challenging (Garousi et al., 2020; Guo et al., 2020; Liebenberg et al., 2015). While the technological gap is relatively easy to bridge through curricula updates, the gap in soft skills development is more complicated to integrate into undergraduate studies (Jiracheewewong, 2022; Stevens & Norman, 2016).

For decades, integrating industry experience into academic curricula has been proposed as a solution to bridge the soft skills development gap (Hanna et al., 2014; Liebenberg et al., 2015; Minor & Armarego, 2005). However, since it is difficult to mimic the authentic, real-world organization environment of complex IS design and development, those proposals remain mostly theoretical (Čandrlić et al., 2020; Jiracheewewong, 2022). As a result, the evolution of students' motivation over time in practical, industry-embedded environments, and its correlation with the development of soft skills, remains poorly examined.

The challenges faced in the process of acquiring knowledge and shifts in motivation are crucial not only for students but also for entry-level professionals in the industry. The vital role of motivation in the learning process (Glynn et al., 2008; Martin, 2010; Santos et al., 2020) underscores its importance beyond academic settings, extending into professional environments. Since knowledge acquisition is fundamental in the high-tech sector, the motivation to learn and overcome

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Contribution to the literature

- This study advances the literature by examining how student motivation evolves throughout an industry-embedded academic course using a mixed-methods and longitudinal approach. It reveals a V-shaped motivational pattern that declines mid-course and partially recovers at the end, a trend rarely documented in previous research.
- The paper extends motivational theory into authentic industrial contexts where students face real organizational demands. It also highlights gender differences in motivational change and their implications for inclusivity.
- The study offers a practical framework that includes scaffolding, mentorship, and a balanced workload to sustain engagement in industry-academic learning environments.

difficulties constitutes an essential aspect of engineering expertise.

With the purpose of investigating the students' motivation during academic courses in industrial settings, we utilized an academic course provided in an industrial setting (Sherman et al., 2022). The remainder of this article is organized as follows. First, we provide the literature background on the topics of academic courses imitating industry settings, and students' motivation. Then, we define research questions, describe the research framework, and methodology. The results section contains detailed data on qualitative and quantitative data analysis. Finally, we discuss the findings and offer directions for future research.

RELATED WORK

Over the years, academic course tutors have discussed various pedagogical approaches to create an environment that resembles practical challenges in IS development. For example, Hadar et al. (2008) suggested teaching undergraduates collaborative software development, Čandrlić et al. (2020) presented a project-based model that simulates a real-life situation for teaching IS design and development, and Gafni et al. (2023) described a capstone project where students apply theoretical knowledge to solving practical problems and developing employability skills. These approaches are known to help students build technical skills, teamwork, and problem-solving abilities. However, while skill development is often emphasized, there is much less research on how students' motivation changes over the course of such practical learning experiences, especially in settings that simulate real work environments and foster soft skills. This section is divided into four parts. First, we will examine project-based learning (PBL), emphasizing its ability to provide students with meaningful, hands-on projects. Then, we will discuss capstone projects, which allow students to apply the knowledge and skills they acquired during their coursework to realistic professional situations. The third section examines academic courses in industry settings, focusing on getting students to experience the industrial workplace as closely as possible. Finally, we examine student motivation, reviewing key theories on intrinsic and extrinsic motivation, self-efficacy, and the evolution of motivation within practical, industrial-related settings.

Project-Based Learning

PBL offers ways to transfer foundational and practical learning knowledge into "real projects for real clients" (Sindre et al., 2018). PBL fosters students' motivation and engagement (LaForce et al., 2017; López-Gazpio, 2021), strengthens students' critical thinking, problem-solving, communication, and teamwork skills (Gafni et al., 2023; Guo et al., 2020), and reinforces students' self-esteem and self-confidence (Doppelt, 2003; Tuyen & Tien, 2021). PBL's true advantage is in offering students the chance and incentive to engage in meaningful projects directly pertinent to their field of study and of personal interest, and essential for success in the workplace (Chandrasekaran et al., 2013). Thus, PBL fosters a perception among students that this learning approach is more stimulating, motivating, and enjoyable than traditional methods (Hsbollah & Hassan, 2022). Although the significant contribution of the PBL approach to students' skills and knowledge development is broadly accepted in the literature (Guo et al., 2020), its academic course setup limits the ability to create maximum similarity with industrial settings. While previous PBL studies demonstrate students' enhanced engagement and motivation using a single assessment point, this paper aims to assess students' motivation changes over time.

Capstone Project

The ability to mimic an industrial setting is addressed by the capstone project approach. This approach offers a culminating and integrative educational experience (Yue et al., 2009), which allows the undergraduate students to leverage the acquired knowledge and apply concepts, skills, and methodologies gained throughout their studies to solve real-world problems (Gafni et al., 2023; Tenhunen et al., 2023). A capstone project gives students a taste of what awaits them in the professional realm (Aller et al., 2008; Bragós et al., 2022) and thus helps students integrate existing knowledge while acquiring new knowledge and enhancing employability skills (Gafni et al., 2023; Keller et al., 2011). PBL can be integrated into capstone courses during the senior year, with the learning objectives of refining technical and professional skills (Pembridge & Paretti, 2010; Rana et al., 2024). According to the literature, collaboration with industry is recommended to make the capstone projects as realistic as possible (Paasivaara et al., 2019). However, existing literature often focuses on technical or teamwork outcomes, not on longitudinal motivational changes. While capstone projects bring students closer to professional work, the level of realism can be further enhanced by applying direct communication with industry partners. Further, courses conducted in actual industry settings immerse students in real-world organizational contexts, which enhance their employability skills through close interaction with professionals and work-related processes.

Academic Courses in Industry Settings

Despite the recommendation for industry involvement in academic courses, there is little evidence in the literature about it. Studies reporting the results of capstone projects mainly refer to the organization's customers as examples representing real-world environments. For example, Paasivaara et al. (2019) described the participation of industry customers in a scrum-based capstone project course. The organization's customers provided project subjects and fulfilled the product owner role in the student teams. According to Paasivaara et al. (2019), the primary motivation of the companies participating in the course was to facilitate recruitment efforts, accelerate software development, and explore new technologies. In turn, the students' interest in these projects was heightened when they perceived a project as realistic and beneficial to their career development and potential to receive sponsorship from industrial partners (Aller et al., 2008; Latorre & Meier, 2023).

Another type of academy-industry collaboration in the context of academic courses refers to customer-driven courses. This type of course allows students to use skills and knowledge acquired in earlier courses within a practical setting. The projects are carried out in big scrum teams, including five to eight students, and focus on creating a functional prototype (Cico et al., 2021). In such courses, students are provided with problems that need to be solved, and course tutors are responsible for the academic part and project coordination (Bruegge et al., 2015; Cico et al., 2021). Both capstone projects with real customers and customer-driven courses aim to develop an outcome that meets the customers' project goals. A meaningful academic project in industrial settings should be well-defined, significant for the organization, realistic yet challenging for students, motivational, and represent the typical work at the company (Paasivaara et al., 2019). However, projects established in academic environments with academic instructors and industry involvement are typically focused on meeting project requirements and rarely provide real industrial experience for the students. Direct exposure to industry environments not only strengthens technical and professional skills but also shapes students' motivation. Understanding how motivation evolves in these settings is, therefore, critical, which leads naturally to the next subsection focusing on theories and research on student motivation.

Students' Motivation

Educational studies have shown continuous interest in the significance of motivation (Kusurkar et al., 2011; Terrón-López et al., 2017; Young et al., 2018), which is considered to produce eagerness to work and learn new information and skills (Glynn et al., 2008; Santos et al., 2020). Motivation is closely related to self-determination, indicating students' confidence that they possess some level of control and choice in their learning activities (Black & Deci, 2000; Howard et al., 2021; Ormrod et al., 2023). Thus, motivation can be seen as synchronizing an individual's energy and drive to facilitate learning, work effectively, and attain their maximum potential (Martin, 2010). Since fostering academic achievement heavily relies on motivation (Abdelrahman, 2020; Britner, 2008; Britner & Pajares, 2001, 2006; Bryan et al., 2011; Cavallo et al., 2004; Glynn et al., 2006; Pajares, 1996; Savelsbergh et al., 2016), enhancing motivation stands as a primary objective in science education.

Motivation is commonly categorized into intrinsic and extrinsic types. Intrinsic motivation occurs when a student derives enjoyment and interest from the learning activity. The significance of intrinsic motivation lies in that intrinsically motivated students proactively seek ways to master the skills and content necessary for learning (Anistyasari et al., 2024; Cavallo et al., 2003). Intrinsic motivation is more sustainable and under one's control, enabling students to persevere, retain information more effortlessly, and remain enthusiastic about learning. Such students demonstrate a proactive approach to gaining knowledge, taking responsibility for their learning, being open to experimenting with new learning methods, and being unafraid of potential failures in their endeavors (Ainley, 2006; Dev, 1997). In an academic setting, students with intrinsic motivation undertake tasks for the joy of accepting challenges, experiencing self-satisfaction, and finding intrinsic joy, rather than being driven by external incentives or pressures (Baer et al., 2003; Simpkins et al., 2006; Wasko & Faraj, 2005). Such students often exhibit higher levels of confidence, satisfaction, and genuine interest in their tasks. Intrinsic motivation fosters a sense of pride in learning and subject matter, encouraging students to embrace challenges in their educational journey. Therefore, intrinsic motivation emphasizes self-regulation, self-commitment, and self-determination without succumbing to external pressures (Brophy, 2010; Glynn et al., 2011; Savelsbergh et al., 2016).

In contrast, extrinsic motivation is associated with the rewards gained and the avoidance of punishments through successful performance in a learning activity. (Abdelrahman, 2020; Ormrod et al., 2023; Sevinç et al., 2011). Extrinsic motivation is characterized by external factors such as good grades, rewards, promising career prospects, parental approval, and recognition from others (DeLong & Winter, 2002; Glynn et al., 2011). Students driven by extrinsic motivation rely on external elements, aiming for good grades, shaping their careers, and seeking acknowledgment and applause from others for their academic achievements. Additionally, self-efficacy, defined as reflecting students' confidence in their ability to attain desired outcomes in specific domains, significantly influences the learning process (Baldwin et al., 1999; Lawson et al., 2007; Martin et al., 2020).

Traditional lecture-based teaching is associated with low student motivation due to students' different learning styles, cumbersome theoretical load, challenges in the integration of learning materials into practical and applicable knowledge (Terrón-López et al., 2017), and failure to encourage active learning in students (Devadoss & Foltz, 1996; Thambu et al., 2021). Studies analyzing the advantages and disadvantages of student learning through projects representing real-world problems frequently address the subject of student motivation during project work. For example, Murphy et al. (2017) found that interacting with a real-world customer allows students to experience the customer's enthusiasm for the topic, which motivates them to assist the customer in achieving success. Moreover, encouraging students to bridge what they learn in the classroom with real-world applications in their future careers, alongside employing a teaching method that sparks student curiosity and involves hands-on activities, will likely enhance motivation and reduce dropout rates (Terrón-López et al., 2017).

Evaluating changes in motivation is crucial because although instructors do not directly influence a student's initial motivation in a new course, they can potentially affect how student motivation evolves over the semester (Young et al., 2018). Identifying students lacking motivation and understanding the underlying reasons would empower teachers to tailor lessons and promote motivation effectively. There is a belief that as motivation increases, there will be a corresponding improvement in students' physical and cognitive performance. This, in turn, is expected to positively influence their learning and achievement within a specific domain (Abdelrahman, 2020; Campos-Sánchez et al., 2014; Fredricks et al., 2004; Ladd & Dinella, 2009; Lee et al., 2010). Social cognitive theory posits that achievement is significantly influenced by the interplay of students' behavior, characteristics, and the conditions of the learning environment (Bandura, 2001).

Despite extensive research on PBL, capstone, and developing soft skills, some important questions remain unanswered. First, most studies examine motivation at a single point in time, so we know little about how student motivation develops over the course. Furthermore, studies tend to focus on either qualitative or quantitative paradigms, rarely combining both approaches to provide a more complete picture of how motivation changes in real-world settings (Glynn et al., 2011; Kusurkar et al., 2011). Finally, although involving industry representatives in academic projects is widely recommended (Cico et al., 2021; Paasivaara et al., 2019), most studies focus on students' skills and project outcomes rather than on the evolution of students' motivation in an authentic, industry-like environment. Hence, this research aims to longitudinally examine students' motivation in practical courses facilitated by collaboration with industry.

RESEARCH QUESTIONS

To assess students' motivation in practical courses facilitated by collaboration with industry, we defined the following research questions.

1. How does undergraduate students' motivation to attend a practical course that simulates a real-world environment change throughout the course?
2. How do the five motivational factors of science learning change throughout the course?
3. What students' characteristics affect motivational change?

RESEARCH FRAMEWORK

In the following paragraphs, we provide a detailed description of course requirements, syllabus, and instructions.

We collaborated with a global high-tech company to develop a practical learning course (Sherman et al., 2022) named "introduction to open source". The course aimed to achieve two objectives:

(a) instructing students on various aspects of software development methodologies, tools, and practices and

(b) fostering the development and enhancement of soft skills among software engineering undergraduates.

The course simulated an industrial environment, including the guidance of the company staff, software engineers, and academic tutors. The course was defined as an elective, offered to third-year students within the IS bachelor's degree program. Before taking this course, students are required to complete mandatory courses such as *systems analysis and design*, *database design*, and programming courses like *object-oriented programming with Java*, *Python*, and C++.

PBL formed an integral part of the course, wherein the final project was divided into several topics, with each new subject being accompanied by a practical assignment. Teams were required to present their intermediate results to the rest of the class on pre-defined dates. Each team was assigned as a software engineer from the company as a mentor. The mentor's primary role was to provide guidance and offer personal and group feedback to the students. The grading strategy and feedback system were designed to emulate the employee performance evaluation process used in organizations. The evaluation was conducted three times during the course (after week three, week six, and at the end of the course). The grades were based on the quality of deliverables and the learning process, including communication, team coordination, and performance. Class attendance was defined as "recommended" to imitate the industrial settings rather than academic course requirements (obligations).

The course objectives were presented to students before the registration period. Students were informed about the course's objectives, requirements, advantages, and complexities. The industry simulation aspect of the course began as early as the registration process, where students were asked to apply for the course in English. In their applications, students were asked to explain why they were interested in participating in the course.

In the next phase of course registration, students were required to undergo admission interviews. These interviews assessed their motivation as the primary criterion for participation. During the interviews conducted by the company's representatives and faculty staff, each student was informed of the course's high demands and the commitment required for successful completion. Only those who demonstrated a strong willingness to face challenges and a deep desire to succeed were selected to participate. Worth mentioning that the screening process focused on the evaluation of students' motivation and personal skills while not discriminating against those who demonstrate low self-esteem or average grades as opposed to high grades and high self-esteem (see **Appendix A** for interview questions and guidelines).

The screen process provided valuable data to effectively execute the process of assembling student teams, which was carried out by the company staff. The key principle guiding the team's formation strategy was to achieve maximum diversity within each group in terms of professional knowledge, experience, and gender. This assembly occurred after several weeks, which enabled the company's representatives to further assess the students' characteristics.

RESEARCH METHODOLOGY

This study aims to investigate the changes in students' motivation during academic courses in industrial settings. The study spanned over two course occurrences, focused on a 3rd year bachelor's degree student in IS, aged 23-30 years, who actively took part in a practical course delivered by the company experts. In the first course occurrence, we used qualitative techniques to explore students' perceptions regarding the course contributions and motivation challenges. In the second course occurrence, we utilized the science motivation questionnaire II (SMQII) (Glynn et al., 2011). The SMQII is an assessment tool that originated from the science motivation questionnaire (SMQ), widely used and translated into several languages (Campos-Sánchez et al., 2014; Salta & Koulougliotis, 2015), and has been used with both high school and undergraduate students (Covert et al., 2019; Young et al., 2018). The SMQII questionnaire, which depicts five factors of science learning: intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation, was administered three times–before, during, and after the course completion, for assessment of changes in students' learning motivation (Glynn et al., 2011).

First Course Occurrence

The first course occurrence was delivered during the winter semester of 2020. It was delivered entirely online due to COVID-19 restrictions, and a qualitative case study methodology was employed to provide a comprehensive and narrative understanding of the motivation change phenomenon (Yin, 2009). Data collection was conducted through semi-structured interviews, comprising ten open-ended questions. These questions focused on the students' interest in the course, its contributions to their professional and social skills, the learning process, and the course's strengths and weaknesses. The open-ended nature of the questions allowed participants to share their experiences, perceptions, opinions, and feelings freely (see **Appendix B** for semi-structured interview content). The study sample consisted of 14 students who passed the screening process and were assigned to 5 groups. Of these 14 students, 12 agreed to participate, including 7 females and 5 males.

The participants' data was anonymized and coded with randomly assigned codes from P1 to P12. Based on the participants' consent, all interviews were audio-recorded and transcribed. Atlas.ti software was used to organize and facilitate data analysis. Following the principles of provisional coding (Miles et al., 2019), data analysis began with a preliminary conceptual framework based on SMQII constructs. As the analysis progressed, this framework was refined through iterative engagement with the data and the relevant literature. The process involved continuously evaluating and interpreting theoretical constructs in light of the emerging data, ensuring an integrative and dynamic analysis approach.

Second Course Occurrence

The second course occurrence was delivered during the winter semester of 2021, at the company's premises, with two and a half hours of weekly lectures delivered by the company's experts, followed by students' self-learning. A total of 14 students, 9 males and 5 females, who passed the screening process, were assigned to 5 groups. All of the 14 students filled in the questionnaires. Among these students, 12 filled in the pre-, 14 filled in the during-, and 11 filled in the post-questionnaire. 10 students completed both the pre-, during-, and post-questionnaires, with 6 of them being male.

The first questionnaire was administered on paper, while the other two, the during- and post-questionnaire, were conducted remotely using Google Forms.

The SMQII questionnaire includes the motivation's five factors of science learning, each assessed by five questions: intrinsic motivation (questions 1, 3, 12, 17, and 19); self-efficacy (questions 9, 14, 15, 18, and 21); self-determination (questions 5, 6, 11, 16, and 22); grade motivation (questions 2, 4, 8, 20, and 24); and career motivation (questions 7, 10, 13, 23, and 25). Responses were recorded on a five-point Likert scale (1 = never, 2 = rarely, 3 = sometimes, 4 = usually, and 5 = always), with the total possible score ranging from 25 to 125. The score for each domain is calculated as the average of the responses to the five questions in that domain.

Because the instrument can be easily adapted to specific disciplines by substituting the word "science" with the name of the relevant discipline (Glynn et al., 2011), we replaced "science" with "practical course" throughout the questionnaire.

Statistical analysis was undertaken to determine whether learning motivation changes during the course, using the statistical software SPSS (release 20.0.0, IBM SPSS statistics for Windows, IBM Corp., Armonk, NY, USA), supplemented with descriptive statistics of the three repeated measures. Friedman's test is a nonparametric test, used to compare three or more matched groups, and is an ideal statistic to use for a repeated measures type of experiment to determine if a particular factor has an effect (Scheff, 2016). This test is an extension of the Wilcoxon signed-rank test with the additional assumption of sphericity. The null hypothesis for the Friedman test states that all groups have the same median (Marino, 2018). In this study Friedman test was used to determine the extent to which students' motivation changes over time using differences between related samples. The dependent variable was the total score of the five learning satisfaction constructs, and the independent variable was time. Then, each of the five learning satisfaction constructs was tested separately with the independent variable time.

RESULTS

A summary of the motivation categories that emerged from the first course occurrence, and evidence from the interviews, is presented in **Table 1**.

Qualitative Data Analysis

Table 1 shows motivation categories, explanation, and evidence from the field.

Quantitative Data Analysis

The overall motivational change during the practical course is presented in **Figure 1**. The visualized motivational difference change was found statistically significant at the three different stages of the practical course, with $\chi 2$ (2) = 6.82, p = 0.03. This data helps answer research question 1: *How do undergraduate students' motivation to attend a practical course that simulates a real-world environment change throughout the*

Table 1. Motivation categories, explanation, and evidence from the field

Category	SMQII explanation	Evidence from the field–Examples	O
Intrinsic motivation	Intrinsic motivation entails participating in an activity and immersing oneself in it for the sheer joy of the activity itself, rather than for external rewards (Baer et al., 2003; Simpkins et al., 2006; Wasko & Faraj, 2005).	"When this practical course was first offered, I was thrilled, though, at the end of the day, I guess it's not for me" [P5]. "This course was one of the most enriching courses … thus, I worked hard, trying to make the best of it, to learn as much as possible" [P8]. "Students were selected based on their willingness and passion to study by themselves, though, later on were overwhelmed by requirements and wanted to quit" [P3].	7
Self-determination	Self-determination indicating students' confidence that they possess some level of control and choice in their learning activities (Black & Deci, 2000; Howard et al., 2021; Ormrod et al., 2023).	"I was assigned with inexperienced team members, and since most of the time I was unavailable to support them, it led them to stress and frustration" [P9]. "As a working man, flexibility is very important to me, deciding when to sit down and do my assignments. Here, due to the tight schedules and the need to synchronize the teamwork, I had less control over my time" [P12]. "This project required much more work needed to be done with my team members, thus, one can't just do his part at the last moment, be-cause the other team members de-pend on his outputs" [P4].	6

Table 1 (Continued). Motivation categories, explanation, and evidence from the field

Category	SMQII explanation	Evidence from the field–Examples	O
Self-efficacy	Self-efficacy, reflecting students' confidence in their ability to attain desired out-comes in specific domains, holds a significant influence over the learning process (Baldwin 1999; Lawson et al., 2007; Martin et al., 2020).	"The repeated failures to accomplish tasks during the course had some temporal effect on my confidence, however, at the end of the day, overall, my confidence was reinforced" [P5]. "During the semester I felt that I knew nothing, and my deliverables were poor, however, eventually, I realized that I did well. Now I know that these negative feelings aren't always true and that I can succeed even if my current knowledge doesn't cover everything I need to know because I'm capable of searching and finding answers by myself" [P10].	
Career motivation	Career motivation refers to the relevance of the content being taught to one's future career (Glynn et al., 2008, 2011).	"I took this course because I assumed it will enhance my CV, and this assumption was found to be true, when I was accepted to work, and scrolled Slack and saw that my new colleagues were updated by my new manager of my attendance and my participation in this course. Notwithstanding, the substantial challenges accompanying this course helped me to understand that DevOps is not for me" [P5]. "This course helps to get to know the industry, and it's important, although, during the course, it not al-ways felt like that, but eventually attendance is advantageous" [P10].	3
Grade motivation	Grade motivation refers to importance of achieving a good grade in the content being taught.	"I was sure my grade would be poor, eventually, it wasn't like that, and the course grade exceeded my expectations" [P10]. "The course grading didn't affect the decision whether to register or not for the course" [P1]. "The high grade gained in this course was something I hadn't initially anticipated" [P5].	7

Note. O: Occurrences

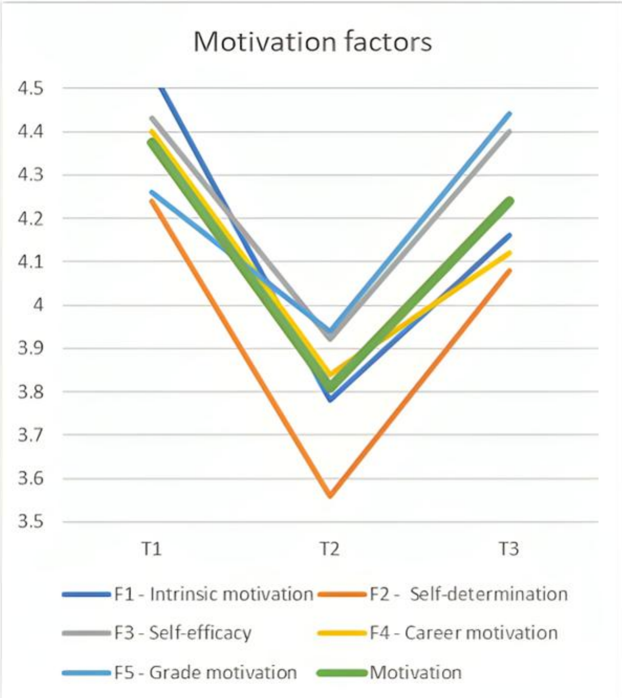

Figure 1. Motivational change during the practical course (Source: Authors' own elaboration)

course? and reveals a decrease in overall motivation during the course, with an increase to some extent at the end of the course.

The other colored lines presented in **Figure 1**, which represent the motivation's five factors of science learning, address research question 2: *How do the motivation's five factors of science learning change throughout the course?* and display a similar V shape to the overall motivation construct, with a high score before the practical course, followed by a diminished score in the middle of the course, and a high score, though lower than the initial score, at the end of the course. The clear and recurring trends of the five factors displayed (**Figure 1**), were further analyzed: Intrinsic motivation difference was statistically significant with $\chi 2$ (2) = 6.61, p = 0.04, career motivation with $\chi 2$ (2) = 4.54, p = 0.10, self-determination with $\chi 2$ (2) = 4.42, p = 0.11 and grade motivation with $\chi 2$ (2) = 4.29, p = 0.11 difference were borderline statistically significant, and self-efficacy with $\chi 2$ (2) = 3.32, p = 0.19 difference was not statistically significant.

Table 2. SMQII constructs scores

Construct	T1 (pre)	T2 (during)	T3 (post)
Intrinsic motivation	4.54	3.78	4.16
Self-determination	4.24	3.56	4.08
Self-efficacy	4.43	3.92	4.40
Career motivation	4.40	3.84	4.12
Grade motivation	4.26	3.94	4.44

The three measures of motivation's five factors of science learning values are presented in **Table 2**.

Insignificant differences were found comparing "general work experience" between females and males; likewise, "English level" differences between females and males were also found insignificant. The effect of

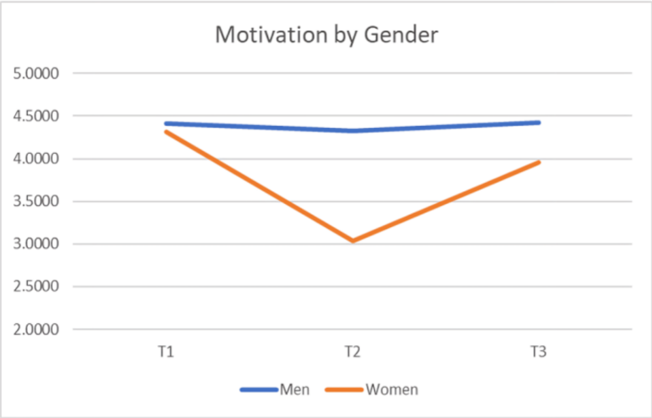

Figure 2. Motivational change by gender, during the practical course (Source: Authors' own elaboration)

gender on students' motivation was previously studied (Young et al., 2018; Zhang et al., 2004), and the results were mixed. Current research compared gender motivational change presents the three times: before, during, and at the end of the practical course

The overall motivational change, categorized by gender, during the practical course is presented in **Figure 2**. The gender-wise visualized motivational change difference was compared using t-tests. The gender t-test comparing males and females before the practical course occurred was not significant, men (mean [M] = 4.42, standard deviation [SD] = .40) and women (M = 4.31, SD = .21); t (8) = .485, p = .641. However, the during and post-questionnaire gender t-test comparisons were significant with men (M = 4.33, SD = .38) and women (M = 3.03, SD = .74); t (8) = 3.715, p = .006, and men (M = 4.43, SD = .29) and women (M = 3.96, SD = .35); t (8) = 2.320, p = .049, respectively. These results help answer research question 3: *What students' characteristics affect motivational change?* and reveal that the decrease in women's overall motivation is more substantial than in men

The gender Welch's t-test comparing males and females' age difference was not significant, men (M = 26.26, SD = 1.69) and women (M = 25.08, SD = 2.16); t (4.628) = .999, p = .367. The gender Welch's t-test comparing males and females' general work experience difference was also insignificant, men (M = 1.99, SD = 2.70) and women (M = 4.00, SD = 2.16); t (7.011) = 1.46, p = .188. The gender Welch's t-test comparing males and females' English level difference was also insignificant, men (M = 3.9, SD = .50) and women (M = 3.50, SD = .58); t (4.900) = 1.518, p = .191. Additional demographic characteristics can be found in **Table 3**.

Table 3. Students' demographic characteristics

Characteristics	Male	Female	Total
Age	26.27	25.08	25.93
General work experience	1.99	4.00	2.56
English level	4.00	3.50	3.86

DISCUSSION

The literature on motivational change indicates varied findings. Some studies have reported a significant decline in certain factors of the five dimensions of science learning motivation (Rybczynski & Schussler, 2013; Zusho et al., 2010), while others have noted a significant decline across all five factors (Young et al., 2018). This study examines motivational changes within a practical, industry-aligned course designed to prepare students for professional environments.

The study's first research question addresses motivational change during the practical course, and the results portray a decline in motivation in mid-course, with a slight increase in motivation towards the end of the course. The practical course's industry-based setting poses unique challenges and learning opportunities. The students' initial high motivation levels are likely influenced by the novelty and perceived prestige of participating in a real-world industrial project. However, as the course progressed, the complexity and demands of the tasks may have contributed to the observed dip in motivation. This V-shaped trend, where motivation declined mid-course and then slightly increased by the end, suggests that while initial enthusiasm wanes with exposure to real-world challenges, the eventual mastery and completion of tasks can restore some of the lost motivation.

The following quotes from the interviews align with this perception:

> "… throughout the semester I thought I didn't have enough skills or knowledge and felt like I didn't know anything and was doing poorly, though, eventually it turned out in the end that this wasn't the case at all" [P10].

> "The approach here was like being thrown into the water. At first, they went with us into the shallow end, so to speak, and then they said: 'Listen, now you need to get to the other side, in the deep end …'" [P2].

> "… and during the course, I really realized that it is much more workable" [P2].

While studies show that students' adaptive motivation tends to decrease as courses progress, one plausible explanation for this phenomenon may relate to the mentor side, their teaching motivation, and students' reported need-based experiences (Cohen et al., 2022). In our case, students reported a midterm high workload. This high workload may affect academic performance, where motivation drops are often tied to academic performance (Young et al., 2018). A possible explanation for the motivation increase towards the end is suggested in Kivetz et al.'s (2006) work, which ties the experience of enhanced motivation to getting closer to the goal, meaning, as students see the course finish line, their effort and motivation increase to reach that goal. Self-determination theory further suggests that waning support or autonomy mid-semester could dampen motivation (Cohen et al., 2022). Our findings imply that to prevent the slump, instructors might maintain novelty or support throughout (consistent with Cohen et al., 2022) calls for sustained autonomy-supportive teaching.

The study's second research question addresses the five motivational factors of science learning change throughout the course. While **Figure 1** shows a similar decrease in all five motivation factors in mid-course, with a slight increase in motivation towards the end of the course, only the Intrinsic motivation factor was found statistically significant. The three factors, career motivation, self-determination, and grade motivation, were borderline with p-values close to .1, and the fifth factor, self-efficacy, was found to be insignificant with a p-value of .19. A type II error happens when an intervention is mistakenly considered ineffective, even though it actually works. Statistically, this occurs when the null hypothesis is incorrectly accepted, leading to a false-negative result. Type II errors are more common when sample sizes are too small (Columb & Atkinson, 2016), and the most common reason for type II error is small sample size (Serdar et al., 2021). Just as a small p-value does not confirm a real effect, a p-value slightly above 0.05 does not indicate the absence of an effect, and an insufficient number of participants may be related to large or moderate standard errors, resulting in borderline p-values (Hackshaw & Kirkwood, 2011). A comparison of the Friedman test effect size (Kendall's W value) of the five factors revealed that Intrinsic motivation had the highest effect size, and since the sample size of the five factors is equal, this may explain the significance of this factor, in contrast with the other factors.

Mixed-methods research (MMR) is increasingly recognized for its capacity to provide meaningful insights through the triangulation of qualitative and quantitative data. This methodological approach addresses the limitations of single-method studies by offering a more comprehensive understanding of research phenomena. One key advantage of MMR is its ability to enhance the validity and reliability of findings. By integrating qualitative insights, which provide context and depth, with quantitative data that offers statistical rigor, researchers can draw more robust conclusions (Headley & Plano Clark, 2020; Sandelowski, 2013). According to Campbell et al. (2019), MMR facilitates thorough analysis by combining diverse data types, appealing to the pragmatic philosophy of gathering multiple perspectives to inform understanding. Thus, the paper's MMR method offers some compensation for the sample size limitation.

It is argued that student discouragement may stem from class feedback and thus play a role in measured self-efficacy decline (Zusho et al., 2010). Some of the interviewees addressed the limited support provided by mentors and the need for more mentorship. They stated that this gap led to extended work hours and affected the quality of their deliverables. Here's a quote that sums this gap:

> "We were expected to learn everything by ourselves, which made it very difficult for people who are just starting out. Often, we were expected to do something far beyond our knowledge, to deal with it on our own, and it's not always easy; sometimes, it just doesn't really work" [P10].

The starting point of the students was unequal, while some students had no prior experience and pleaded for support, others had considerable experience and knowledge; therefore, the limited support offered by the mentors was sufficient. This may explain the self-efficacy factor's insignificant results. Examination of effect size revealed that the self-efficacy effect size was lower than the other four factors, and since the sample size of the five factors is equal, this may also provide an explanation for the insignificant results of this factor.

The third research question of the study was focused on identifying which student characteristics influence changes in motivation. Differences in general work experience, age, and English level between the two genders were found to be insignificant. However, while the differences in motivation levels were found to be insignificant at the beginning of the course, later on, during and after the course, these differences became significant. This increased difference also corresponds with **Figure 2**. While men's motivation change is minor, women's motivation is substantial.

The gender difference is noteworthy and raises questions about underlying causes. One possible explanation involves socio-cultural dynamics that differentially affect women. For example, women in technical and STEM fields often encounter implicit biases and stereotypes, as well as feelings of isolation or "imposter syndrome," which can undermine confidence and persistence (Stofer, 2024). Although our study did not measure these factors directly, we acknowledge that such gendered experiences could contribute to the pattern observed. In light of this finding, we have expanded our discussion to consider inclusivity and equity issues. This involves recognizing potential barriers that women may face and exploring strategies to support them.

One well-established strategy is mentoring: connecting women with supportive role models and networks. Mentoring relationships provide career guidance, confidence-building, and socio-emotional support (Stofer, 2024). For example, female peer mentoring programs have been shown to increase the persistence of women in STEM by boosting confidence and sense of belonging (Freedman et al., 2023). Such mentoring can help counteract the stereotype threat and isolation described above.

Another complementary strategy is the scaffolding of the learning experience. This means providing structured support and inclusive pedagogy to ensure all participants can succeed. Equity-driven scaffolding interventions (for example, deliberate team-building activities and carefully designed group assignments) have been shown to significantly raise participation and reduce gender engagement gaps (Ribeiro et al., 2024). By analogy, industry-embedded learning programs could incorporate gender-aware scaffolding, such as pairing mentors with interns or adjusting tasks to build skills progressively, to create a more inclusive environment.

Most of the students had no prior industrial experience, and the course was designed to expose them to the industry, bridge the gap to the high-tech sector, and prepare them for their next phase as future employees. However, the interviews suggest that while four out of the five motivational factors for science learning were highlighted by most interviewees, only three participants addressed the career motivation factor (see **Table 1**). This phenomenon may be explained by students' perception of the course as primarily academic, leading them to overlook its potential long-term benefits.

CONCLUSIONS

This study found that student motivation in an industry-based course dipped markedly at the mid-point and only partially rebounded by the end of the term. In other words, after an initial decline in engagement during the course's intensive middle phase, students' enthusiasm began to recover as they neared completion–an outcome consistent with the "goal-gradient" effect where motivation surges upon seeing the finish line. This mid-course slump, contrasted with the late-course uptick, underscores the need for targeted support during the most challenging weeks. Even in authentic real-world learning environments, educators must not assume motivation will remain steady. Instead, deliberate intervention is required to sustain student engagement throughout the course's duration. The findings, therefore, carry important implications for the design of industry-integrated curricula and for instructor development, highlighting when and how to bolster student motivation for maximum educational benefit.

Building on these insights, we recommend several evidence-based strategies to maintain and even enhance motivation as students "dive" into deep, real-world projects. First, motivational scaffolding should be built into the curriculum - breaking complex tasks into manageable phases and gradually increasing their complexity as students gain confidence. This approach prevents students from becoming overwhelmed early on and motivates them to learn by allowing incremental successes. A related design principle is a phased workload–distributing project milestones and assessments in a balanced way across the semester to avoid an excessive workload spike at mid-course, which has been linked to drops in performance and morale. Second, the course should incorporate continuous mentorship. Having dedicated mentors or industry practitioners engage with student teams on a regular basis provides the guidance and encouragement that our participants felt was lacking during their hardest moments. Such mentorship–coupled with an autonomy-supportive teaching style–helps students navigate challenges without losing motivation, aligning with calls in the literature for sustained need-supportive instruction in long-term projects. Third, educators should establish frequent formative feedback loops and reflection sessions. Regular check-ins with constructive feedback allow students to recognize their progress and address difficulties promptly, which can reinforce self-efficacy instead of allowing discouragement to fester. These measures also call for enhancements in teacher training: instructors of industry-based courses should be prepared to act as facilitators and coaches, not only imparting technical knowledge but also actively fostering student motivation through support and realistic feedback. Taken together, these strategies create a framework for curriculum design that keeps students engaged from the initial immersion in real-world tasks to the course's conclusion. By anticipating the mid-semester motivational dip and proactively implementing mentorship, scaffolding, balanced workloads, and feedback mechanisms, educators can ensure that "jumping into deep waters" remains a productive and motivating experience for students, ultimately improving learning outcomes and readiness for professional challenges.

Limitations

This study has some limitations. First, the limited sample size increases the risk of type II errors, where meaningful effects might not reach statistical significance due to insufficient statistical power. This limitation may affect the generalizability and interpretation of specific results, particularly for constructs showing borderline significance. Thus, a larger and more diverse sample may enhance insights regarding the motivational trends and effectiveness of support strategies. Second, reliance on the validated SMQII instrument may not reflect the entire dimensions of student motivation relevant to the specific context of an industry-based course. Third, mentors' support and feedback are subject to mentoring style, experience, engagement, and mentors' motivation, and require further study. Fourth, external factors such as the COVID-19 pandemic and students' concurrent academic workload might impact their availability, engagement, motivation, and performance, and thus, affect the experience.

Future Work

The current study may serve future research to enhance understanding and address the limitations discussed. Future research with larger and diverse samples will enable us to provide additional insights into the findings, and the use of additional motivational measurement tools may provide a wider perception of students' motivation. Future courses, with different support and feedback levels by mentors, may provide additional insight into the mentors' role and impact, and the launch of future courses without COVID-19 constraints may imply the computer-mediated-communication effect on students' motivation.

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APPENDIX A: COMPANY'S INTERVIEWS

Interviews Guidelines

The goal is to pick up 20 students who are capable of getting the most out of the course.

We should emphasize that the course is VERY intense and requires a LOT of coding.

Please pay attention to D&I:

- Do not fail those who present low self-esteem
- Do not fail those who do not have the highest grades

Pay attention to motivation and personal skills as opposed to high grades and high self-esteem.

Please provide a short summary of the company and your role at the beginning of the interview.

Pay attention to students who present qualities that are suitable for the company.

Interview Questions

- How much coding experience do you have?
  - Linux, working with CLI
- Do you have additional intense courses this semester?
- Why do you want to take this course?
- What do you think you will gain from this course?
- Have you worked on projects in teams/pairs?
- How much experience do you have with writing/reading technical text in English?

APPENDIX B: SEMI-STRUCTURED INTERVIEW TEMPLATE

Good evening and a pleasant week, ____,

Thank you very much for agreeing to dedicate your time to this interview!

We are conducting research on students' opinions regarding elective/experiential courses in which you participated.

Interview format: The interview will be an open conversation aimed at understanding your perspective on the topic.

Privacy and confidentiality: In this study, full confidentiality regarding participants' identities will be maintained, and your identity will not be disclosed in any research outputs.

The interview will be recorded for the purpose of data extraction and analysis. Before analyzing the data, the interview will undergo anonymization, and all names of individuals, projects, and processes will be removed or replaced with codes.

You can stop the interview at any time.

Do you have any questions before we begin?

Are you ready to start?

Today's date and time:

Part A–Practical Course Insights

Questions

1. **What criteria did you use to choose an elective course?**
2. **Why did you decide to participate in this course? What were your motivations?**
   - Please elaborate/explain/justify.
   - To what extent did the grade you expected to receive influence your decision?
3. **What are the advantages/disadvantages of this course compared to other courses in your degree program?**
4. **What do you think this course contributed to you?**
   - On a personal, professional, and social level (please elaborate/explain/justify).
5. **If you were to take this course again, what would you recommend changing?**
   - Please elaborate/explain/justify.
6. **How has the knowledge you gained on this course influenced (or will influence) your career path?**
   - Please elaborate/explain/justify.
7. **What impact did working in a team have on the effectiveness of learning on this course?**
   - How was teamwork on this course similar to or different from teamwork in other courses in your degree?
   - How did the use of Slack pose challenges, disrupt, or contribute to your experience?
   - What types of messages in Slack did you prefer not to respond to?
   - What types of messages in Slack did you find interesting to respond to?
8. **How did the course affect your confidence in the field overall, your confidence in job searching, and your confidence in integrating into a company in the industry?**
9. **Was Zoom used in the course? If so, how did Zoom influence your experience?**
10. **Do you have any written feedback?**
    - If so, can we receive a copy of it?
    - How did feedback discussions contribute to improving the course and to your personal development?
11. **Would you like to add anything else relevant to this interview?**

Part B–Demographic Questions

*Required

1. **Gender*** (*Mark only one oval*).

   Male
   Female
   Other

2. **Age***

3. **What is your general work experience (in years)*?**

4. **What is your work experience in cyber security (in years)*?**

5. **What is your first language (mother tongue)*?**

6. **What is your English level? Poor (1), adequate (2), good (3), excellent (4), and mother tongue (5)*** (*Mark only one oval*).

	1	2	3	4	5	
Poor						Mother tongue