

Article

Empowering student entrepreneurship skills: A software engineering course for innovation and real-world impact

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CITATION

Alenezi M, Akour M. (2024). Empowering student entrepreneurship skills: A software engineering course for innovation and real-world impact. *Journal of Infrastructure, Policy and Development*. 8(13): 9088. <https://doi.org/10.24294/jipd9088>

ARTICLE INFO

Received: 11 September 2024

Accepted: 23 September 2024

Available online: 8 November 2024

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Abstract: This paper presents a practical approach to empowering software entrepreneurship in Saudi Arabia through a unique course offered by the Software Engineering department at Prince Sultan University. The course, SE495 Emergent Topics in Software Engineering: Software Entrepreneurship, combines software engineering and entrepreneurship to equip students with the necessary skills to develop innovative software solutions that solve real-world problems. The course covers a range of topics, including platform development, market research, and pitching to investors, and features guest speakers from the industry. By the end of the course, students will have gained a deep understanding of the software development process and its intersection with entrepreneurship and will be able to develop a working prototype of a software solution that solves a real-world problem. The course's practical approach ensures that students are well-prepared to navigate the complexities of the digital and software sectors and succeed in an ever-changing business landscape.

Keywords: software entrepreneurship; innovation and technology; startups and SMES; user experience; entrepreneurship education

1. Introduction

The rapid transformation of Saudi Arabia into a digital economy has created a pressing need for effective approaches to entrepreneurship education, particularly in the context of software entrepreneurship (Mahmud, 2020). This field lies at the intersection of entrepreneurship education, software engineering, and innovation management, and is critical for driving economic growth and diversification in the country (Ahmad et al., 2023). Despite its importance, software entrepreneurship education in Saudi Arabia faces significant challenges, including a lack of practical approaches to teaching software entrepreneurship and a need for more effective integration of software engineering and entrepreneurship education (Sitaridis and Kitsios, 2024).

Research in entrepreneurship education has highlighted the importance of experiential learning and the need for students to develop a range of skills, including entrepreneurial mindset, business planning, and innovation management (Ghafar, 2020; Morland et al., 2021). However, there is a lack of research on the specific context of software entrepreneurship education, particularly in the Middle East and North Africa (MENA) region. This paper aims to contribute to this growing body of research by exploring the practicality and importance of software entrepreneurship education in Saudi Arabia.

Software engineering is a critical component of software entrepreneurship, and research in this field has highlighted the importance of agile development methodologies, user experience design, and platform development (Alsolamy, 2023; Cico et al., 2021). However, there is a need for more research on the intersection of software engineering and entrepreneurship education, particularly in the context of Saudi Arabia (Akinwale et al., 2020).

Innovation management is also a key aspect of software entrepreneurship, and research in this field has highlighted the importance of innovation ecosystems, entrepreneurial networks, and government support for entrepreneurship (Abdulrab et al., 2021; Akinwale et al., 2020; Fernandes and Ferreira, 2022). This paper will explore the opportunities and challenges associated with software entrepreneurship in Saudi Arabia, including the role of government initiatives such as the Saudi Vision 2030 program in supporting entrepreneurship and innovation (Alenezi and Akour, 2022; Ahmad et al., 2023; Alenezi and Akour, 2023; Alenezi et al., 2023).

Figure 1 shows how startups are usually developed in phases. The development of a startup typically unfolds in three distinct phases: Formation, Validation, and Growth. The Formation phase marks the inception of the startup, where the founders come together to conceptualize and define their business idea, mission, and vision. During this phase, the team is formed, and the initial product or service is developed. The Validation phase follows, where the startup tests its product or service with a small group of customers to validate its assumptions and gather feedback. This phase is critical in refining the offering, identifying market needs, and determining the startup's unique value proposition. Finally, the Growth phase is characterized by rapid scaling, where the startup expands its customer base, increases revenue, and solidifies its market position. In this phase, the company refines its operations, builds strategic partnerships, and continues to innovate to stay ahead of the competition.

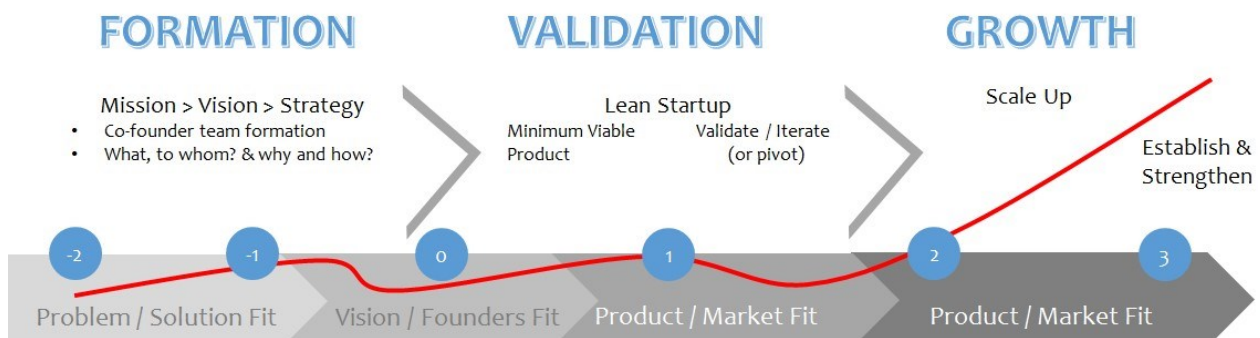


Figure 1. Startup development phases.

By exploring the practicality and importance of software entrepreneurship education in Saudi Arabia, this paper aims to This article makes several key contributions to the field of software entrepreneurship education, particularly within the context of Saudi Arabia: Bridging the Gap between Software Engineering and Entrepreneurship Education: The article addresses a significant gap in existing research by exploring the intersection of software engineering and entrepreneurship education. While entrepreneurship education and software engineering have been studied independently, this work provides a practical framework for integrating the

two, offering a cohesive educational model that equips students with both technical and entrepreneurial skills. Contextualized Educational Approach for Saudi Arabia: Given the rapid digital transformation and the goals outlined in Saudi Vision 2030, this study provides a tailored educational approach that focuses on fostering software entrepreneurship in Saudi Arabia. The research explores the unique challenges and opportunities within the region, offering a contextually relevant curriculum that supports the growth of the digital economy. Application of Lean Startup and Design Thinking: The article demonstrates how methodologies like Lean Startup and Design Thinking can be effectively incorporated into software entrepreneurship education. It details how these frameworks are integrated into teaching methods such as project-based learning, case studies, and practical exercises, providing students with hands-on experience in real-world entrepreneurial processes. Empirical Evidence of Effectiveness: By incorporating both direct and indirect assessments of student learning outcomes, the article provides preliminary empirical evidence that the integrated educational approach positively impacts students. This contribution adds value to the limited research on the effectiveness of software entrepreneurship education in the MENA region. Recommendations for Policy and Curriculum Development: The article provides practical recommendations for educators and policymakers on how to structure courses that integrate software engineering with entrepreneurship. These recommendations aim to enhance the quality of entrepreneurship education, align with industry needs, and support national economic goals.

2. Literature review

Entrepreneurship education (EE) has gained rapid growth and recognition for its potential to strengthen business education, innovation, and economies (Carpenter and Wilson, 2022). This systematic review examines the impact of EE on higher education students by synthesizing the findings of 10 high-quality studies. The review reveals that experiential programs and university extracurricular programs effectively promote entrepreneurship, leading to positive learning outcomes such as business opportunity identification, risk propensity, and entrepreneurial passion. However, methodological limitations, including inadequate program descriptions, reliance on correlational survey designs, and self-selection bias, hinder the establishment of causal effects. Future research should address these limitations and provide evidence-based guidance for EE practice to enable effective teaching and learning and achieve long-term educational, economic, and social outcomes.

Another study focuses on the relationship between entrepreneurship education, entrepreneurial self-efficacy, and entrepreneurial intentions among college students in China (Wu et al., 2022). The study finds that entrepreneurship education positively influences entrepreneurial self-efficacy and entrepreneurial intentions. Moreover, entrepreneurial self-efficacy plays a complete mediating role between entrepreneurship education and entrepreneurial intentions. The study also highlights the moderating effect of entrepreneurial competition experience on the relationship between entrepreneurial self-efficacy and entrepreneurial intentions, with participation in entrepreneurial competitions strengthening this link. The findings

imply that entrepreneurship education programs should prioritize building students' entrepreneurial self-efficacy and providing practical experiences and competition opportunities. To enhance the study's validity, future research should consider longitudinal designs and objective measures of entrepreneurial intentions.

In Indonesia, a study explores the role of entrepreneurship education in increasing entrepreneurial intention among undergraduate business students (Astiana et al., 2022). The study reveals that perceived desirability, perceived feasibility, propensity to act, and entrepreneurship education all have a positive and significant impact on entrepreneurial intentions. Specifically, perceived desirability exerts the strongest influence, followed by perceived feasibility and propensity to act. Students who receive entrepreneurship education exhibit higher levels of entrepreneurial intentions. The findings suggest that entrepreneurship education plays a crucial role in fostering entrepreneurial intentions, emphasizing the importance of developing students' perceived desirability, feasibility, and propensity to act. Future research can address limitations by employing more objective measures and extending data collection to a broader range of students.

A systematic review analyzes the effectiveness of entrepreneurship education programs (EEPs) in promoting entrepreneurial skills and culture (Jardim et al., 2021). The review covers 29 articles published between 2000 and 2020, examining programs in European, Asian, and American countries. The results demonstrate that EEPs effectively promote entrepreneurial skills, particularly in primary and secondary education, and have a moderate effect on activating entrepreneurial intent. The review emphasizes the influence of personal predispositions, family, economic, and cultural contexts in shaping entrepreneurial projects. The authors recommend prioritizing EEPs in early school years to cultivate entrepreneurial skills and intentions. They also advocate for an interdisciplinary approach that integrates innovation, initiative, and teamwork into school curricula to foster an entrepreneurial culture. Overall, the review suggests that EEPs play a crucial role in promoting a global entrepreneurial culture and addressing societal challenges.

Shifting the focus to the intersection of software development and entrepreneurship, the literature review aims to provide an overview of the current state of knowledge in this field (Cico et al., 2021). Software entrepreneurs are key drivers of innovation and growth in the software industry (Filser et al., 2019; Laato et al., 2023). They possess the ability to identify market opportunities and develop software products that effectively meet customer needs. Additionally, software entrepreneurs handle essential business aspects of software development, such as marketing, sales, and finance (Sudirman et al., 2020). However, they face challenges due to intense competition, limited resources, and the need for continuous innovation (Agustian et al., 2023; Fong et al., 2020; Soto-Acosta, 2024).

Despite the challenges, software entrepreneurship can yield rewarding outcomes when entrepreneurs effectively navigate the industry. Successful software entrepreneurs create innovative solutions that address real-world problems, generating value for customers and stakeholders. Entrepreneurial education and training contribute to the success of software entrepreneurs (Azim and Hariri, 2018; Hameed and Irfan, 2019). In Saudi Arabia, various factors, including government support, education, infrastructure, and cultural values, influence software entrepreneurship

(Abdulrab et al., 2021; Alammari et al., 2018; Al-mani, 2020; Alwakid et al., 2020). Empowering software entrepreneurship in Saudi Arabia requires a holistic approach that considers these factors.

Digital entrepreneurship, particularly in the context of software, is a rapidly evolving area that requires a comprehensive understanding (Shen et al., 2018). Teaching software entrepreneurship, with a focus on the discovery and delivery stages, has proven valuable (Salas, 2017). Digital entrepreneurship drives innovation systems, offering both opportunities and disruptions (Satalkina and Steiner, 2020). Entrepreneurship education, with innovative approaches such as experiential learning, incubators, and collaboration with industry partners, can effectively prepare students for the challenges and opportunities of digital entrepreneurship (de Waal and Maritz, 2022).

Below is the summary of findings in the literature:

- 1) **Identifying the Gap in Software Engineering and Entrepreneurship Education:** While there is substantial research on entrepreneurship education and software engineering independently, there is limited research exploring the intersection of these two fields—particularly how entrepreneurship education can be effectively integrated into software engineering curricula. Existing studies (e.g., Alsolamy, 2023; Mahmud, 2020) have largely focused on the benefits of teaching entrepreneurship skills or the technical aspects of software development, but they rarely explore how both can be combined in a cohesive educational framework that fosters entrepreneurial software engineers.
- 2) **Challenges Specific to Software Entrepreneurship Education:** In Saudi Arabia and the broader MENA region, there is a lack of practical, integrated approaches to software entrepreneurship education (Sitaridis and Kitsios, 2024). While experiential learning approaches are well established in general entrepreneurship education (Ghafar, 2020), the unique requirements of software engineering, such as agile development, user-centered design, and rapid prototyping, are often not fully addressed in entrepreneurship education. This creates a gap where students might learn entrepreneurial concepts but lack the practical technical grounding to apply them effectively in the software industry.
- 3) **Need for Research on Contextual Integration:** Our literature review highlights that while research has explored individual elements of entrepreneurship education (e.g., business planning, innovation management), few studies focus on how these elements can be integrated with software engineering principles. For instance, there is insufficient research on how software engineering methodologies such as agile development can be taught alongside entrepreneurial skills like customer validation and lean startup methodologies (Akinwale et al., 2020).
- 4) **Lack of Empirical Studies in Saudi Arabia:** Additionally, the regional context presents a unique gap. In Saudi Arabia, despite efforts under Vision 2030 to promote digital transformation, there is a lack of empirical studies on the effectiveness of integrating software engineering and entrepreneurship education. Current studies (e.g., Abdulrab et al., 2021) highlight the need for entrepreneurial ecosystems but do not address how these ecosystems can be effectively supported through education that integrates software engineering and entrepreneurship.

- 5) **Proposed Contribution to Address the Gap:** Our study aims to address this gap by exploring how to practically integrate software engineering principles into entrepreneurship education in Saudi Arabia. This will help create a cohesive educational framework that equips students with both the technical and entrepreneurial skills needed to succeed in the software industry.

Overall, the literature highlights the positive impact of entrepreneurship education on students' entrepreneurial skills, intentions, and self-efficacy. It emphasizes the need for experiential learning, practical experiences, and competition opportunities to enhance the effectiveness of entrepreneurship education programs. Moreover, the literature recognizes the importance of early education in cultivating entrepreneurial skills and fostering an entrepreneurial culture. In the context of software entrepreneurship, the literature emphasizes the role of education and training in empowering software entrepreneurs and addressing industry challenges. It also stresses the significance of government support, infrastructure, and cultural values in promoting software entrepreneurship.

3. Course design

This section provides a comprehensive overview of the course, covering its background, course map, assessment methods, course project, and learning pedagogy.

3.1. Background

In the midst of Saudi Arabia's vision to empower SMEs and startups, the Software Engineering department at Prince Sultan University has taken the initiative to offer a unique course that combines software engineering and entrepreneurship (Ahmad et al., 2023; Alsolamy, 2023). This course, SE495 Emergent Topics in Software Engineering: Software Entrepreneurship, aims to equip students with the necessary skills to excel in the digital world and develop innovative software solutions that solve real-world problems.

The course is designed to provide students with a comprehensive understanding of the software development process, from ideation and design to development and launch, while also learning essential entrepreneurial skills such as market research, customer validation, and pitching to investors. The course emphasizes the importance of user experience and user interface design and teaches students how to develop a working prototype of a software solution that solves a real-world problem.

The course is structured around eight activities, each of which focuses on a specific aspect of software entrepreneurship. The activities are designed to provide students with practical experience in software development, market research, and pitching to investors. The course also features four guest speakers who are entrepreneurs and product managers, providing students with valuable insights into the industry.

The course covers a range of topics, including models and mechanisms, ideation and design, development and prototyping, securing funding, launching and marketing, organizational development, and exit strategies. The course also includes case studies of successful startups in Saudi Arabia, such as AQAR, Zid, Tabby, Foodics, Tamara,

Tarjama, and HajjGuide. More details of these case studies can be found on the course website (<https://malenezi.github.io/malenezi/SE495/>).

By the end of the course, students will have gained a deep understanding of the software development process and its intersection with entrepreneurship and will be able to develop innovative software solutions that solve real-world problems. They will also have the skills to conduct market research, validate product ideas, and pitch their ideas to investors, as well as the ability to develop a working prototype of a software solution that solves a real-world problem.

The course is aligned with the Saudi Vision 2030, which aims to promote entrepreneurship and investment in the country. It is also in line with the SWEBOK v4, which emphasizes the importance of entrepreneurial aspects in software engineering.

Overall, this course is a unique opportunity for students to gain the skills and knowledge needed to succeed in the software industry and contribute to the growth of the digital economy in Saudi Arabia.

3.2. Course map

The “Software Entrepreneurship” course takes a project-based learning approach, where students work in teams to develop their own software solutions, guided by the principles of software entrepreneurship. This approach enables students to apply theoretical concepts to real-world problems, fostering a deep understanding of the software development process and the entrepreneurial mindset. To further enrich the learning experience, industry guest speakers share their experiences and insights, providing students with valuable networking opportunities and exposure to the latest trends and best practices in software entrepreneurship. Moreover, our mentorship program pairs students with experienced entrepreneurs and industry experts, who offer guidance and support in refining their ideas and developing their products.

The course design is carefully structured to cover the key aspects of launching and growing a software startup, with a specific focus on the Saudi Arabian market. The 15-week course is divided into eight topics, each with a specific objective and set of activities. This comprehensive design ensures that students gain a thorough understanding of the software development process, entrepreneurship, and the intersection of these two fields. By the end of the course, students will have developed a solid foundation in software entrepreneurship, preparing them to successfully navigate the challenges of launching and growing a software startup in the Saudi Arabian market. This course has six learning outcomes:

- CLO1: Understand the software development process and its intersection with entrepreneurship.
- CLO2: Develop skills in ideation, design, and prototyping of software solutions.
- CLO3: Learn how to conduct market research and validate product ideas.
- CLO4: Understand the importance of user experience and user interface design.
- CLO5: Learn how to pitch ideas to investors and secure funding.
- CLO6: Develop a working prototype of a software solution that solves a real-world problem.

Figure 2 shows the course map stages. The course begins with an introduction to the objectives, software development process, and the importance of entrepreneurship in Saudi Arabia. This sets the foundation for the following topics, which dive deeper into the various aspects of software entrepreneurship.

The second topic, “Models and Mechanisms”, introduces the Lean Startup Model, Business Canvas Model, and Value Proposition Canvas. These tools are essential for startups to understand their market, customer needs, and create a successful business model. The case study of Zid, a Saudi Arabian startup, provides a practical example for students to learn from.

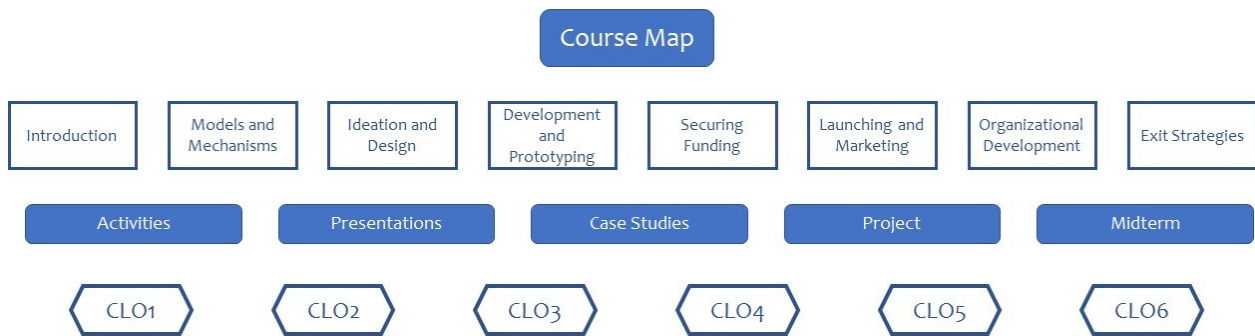


Figure 2. Course map.

The third topic, “Ideation and Design”, focuses on understanding problems and generating innovative ideas using design thinking techniques. This is a critical aspect of software entrepreneurship, as startups need to create solutions that solve real-world problems. The case study of Tabby, a successful Saudi Arabian startup, demonstrates the importance of user experience and user interface design.

The fourth topic, “Development and Prototyping”, discusses the different stages of software development and the importance of agile development and scrum methodology. Students will also learn about prototype development and creating a minimum viable product (MVP). The case study of Foodics, a Saudi Arabian startup, provides insights into the challenges and opportunities of developing a virtual event planning platform.

The fifth topic, “Securing Funding”, is crucial for startups, as they need to secure funding to launch and grow their business. Students will learn how to craft a compelling pitch for investors, understand the different types of funding options available, and appreciate the importance of financial planning and budgeting. The case study of Tamara, a Saudi Arabian startup, provides a real-world example of how to secure funding successfully.

The sixth topic, “Launching and Marketing”, focuses on developing a business plan and marketing strategy, understanding the importance of branding and positioning, and leveraging digital marketing and social media for startup success. The case study of HajjGuide, a Saudi Arabian startup, demonstrates how to create a successful marketing strategy for a software solution.

The seventh topic, “Organizational Development”, discusses the importance of organizational development and team building, as well as the different roles and responsibilities within a startup. Students will also learn about agile management and leadership, which is critical for startups to adapt to changing market conditions. The

case study of Tarjama, a Saudi Arabian startup, provides insights into building a successful team and creating a positive company culture.

The final topic, “Exit Strategies,” discusses the different types of exit strategies available for startups, the importance of planning for an exit from the beginning, and the concept of mergers and acquisitions. The case study of Careem, a successful Saudi Arabian startup, demonstrates how to plan for an exit and create a successful exit strategy.

Throughout the course, students will engage in various activities, such as group discussions, case studies, and hands-on exercises, to reinforce their learning. Guest speakers who are entrepreneurs and product managers in the software industry will share their experiences and insights, providing students with real-world examples and practical advice.

Table 1 reveals the main course’s activities assessments and the assigned grades. The assessment method, which includes participation in class discussions, group assignments, and individual projects, ensures that students are engaged and motivated throughout the course. By the end of the course, students will have gained a comprehensive understanding of the software development process and its intersection with entrepreneurship, as well as the skills and knowledge needed to succeed in the software industry and contribute to the growth of the digital economy in Saudi Arabia.

Table 1. Assessments and grading.

Activity	Grade
Two Presentations	10%
Activities and Case Studies	20%
Project	20%
Midterm	10%
Final Exam	40%

Overall, the course design for “Software Entrepreneurship” effectively addresses the key aspects of launching and growing a software startup in Saudi Arabia. The course’s focus on practical applications, case studies, and guest speakers provides students with a comprehensive and engaging learning experience. By the end of the course, students will be well-prepared to succeed in the software industry and contribute to the growth of the digital economy in Saudi Arabia.

Each activity will be delivered through a combination of lectures, case studies, group discussions, and hands-on exercises. Students will be assessed based on their participation in class discussions, group assignments, and individual projects.

The course will also feature guest speakers who are entrepreneurs and product managers in the software industry. They will share their experiences and insights on the challenges and opportunities of starting and growing a software startup in Saudi Arabia.

By the end of the course, students will have gained a comprehensive understanding of the software development process and its intersection with entrepreneurship. They will be able to develop innovative software solutions that solve

real-world problems and will have the skills and knowledge needed to succeed in the software industry and contribute to the growth of the digital economy in Saudi Arabia.

The course is designed to address the different needs of students and utilize various teaching methods to effectively deliver Entrepreneurship education. The course is structured to provide a comprehensive overview of the software development process, from ideation and design to development and launch, while also emphasizing the importance of entrepreneurial skills such as market research, customer validation, and pitching to investors. This approach ensures that students gain a solid understanding of the intersection of software engineering and entrepreneurship, as well as the practical skills needed to succeed in the industry.

To cater to different learning styles and engagement levels, the course incorporates a variety of teaching methods, including interactive activities, case studies, and guest lectures. For instance, students will participate in a Lean Startup Model simulation, a Business Canvas Model exercise, and a Value Proposition Canvas activity, which will help them understand the practical application of entrepreneurial concepts. Additionally, the course will feature case studies of successful startups in the Saudi market, such as Zid, Tabby, Foodics, and HajjGuide, to provide students with real-world examples and insights into the local entrepreneurial ecosystem.

The course also includes guest lectures from experienced entrepreneurs and product managers, who will share their insights and experiences in the industry. This will not only provide students with valuable networking opportunities but also give them a chance to learn from the best practices and mistakes of successful entrepreneurs. Furthermore, the course will use a flipped classroom approach, where students will be expected to watch video lectures and read course materials before class, and then use class time to work on practical exercises and projects that apply the concepts they have learned.

To further support student learning and engagement, the course will also include a variety of assessments, such as activities, presentations, midterm, group projects, and a final pitch presentation. These assessments will not only evaluate students' understanding of the course material but also encourage them to apply their knowledge and skills to real-world scenarios. Overall, the course is designed to provide students with a comprehensive and engaging learning experience that prepares them for the challenges and opportunities of software entrepreneurship in Saudi Arabia.

3.3. Course project

The project involves developing a minimum viable product (MVP) and a minimum viable business plan (MVBP) for a software solution that solves a real-world problem. The project will be managed using the scrum framework, which emphasizes flexibility, customer satisfaction, and team collaboration.

The project will be divided into four iterations, each with a specific focus. The first iteration will be dedicated to market segmentation and customer exploration, where the team will conduct market research to identify potential customers and their needs. The second iteration will focus on creating a business model canvas and product brochure, which will outline the product's features, benefits, and revenue streams.

The third iteration will be dedicated to testing the MVP and conducting sprint retrospectives, where the team will gather feedback from customers and stakeholders to improve the product. The final iteration will focus on preparing a pitch deck and a minimum viable business plan, which will outline the company's vision, mission, and strategies for growth.

Throughout the project, the team will work collaboratively to ensure that the product meets the needs of the target market and that the business plan is viable. The team will also conduct peer evaluations to ensure that each member is contributing to the project's success.

The final project presentation will be delivered to a panel of judges and will consist of a 10-minute presentation followed by a 5-minute Q and A session. The presentation will showcase the team's MVP and MVBP and will demonstrate how the product solves a real-world problem. The judges will evaluate the team's performance based on the quality of the product, the viability of the business plan, and the team's collaboration and communication skills.

Overall, this project will provide students with a comprehensive understanding of the software development process, from ideation and design to development and launch, while also learning essential entrepreneurial skills such as market research, customer validation, and pitching to investors. By the end of the project, students will have gained a deep understanding of the software development process and its intersection with entrepreneurship and will be able to develop innovative software solutions that solve real-world problems.

3.4. Learning pedagogy

Our approach to teaching software entrepreneurship is grounded in two widely recognized frameworks: design thinking and the lean startup methodology (Lichtenthaler, 2020; Sreenivasan and Suresh, 2024). These frameworks are essential for innovation and entrepreneurship, as they emphasize empathy, creativity, experimentation, rapid iteration, customer feedback, and data-driven decision-making. By integrating these frameworks into our course design and delivery, we provide students with a comprehensive understanding of the software entrepreneurship process and the skills necessary to succeed in this field. Research has shown that entrepreneurship education can have a positive impact on entrepreneurial intentions, self-efficacy, and ultimately, the creation of new ventures (Cao et al., 2022; Rabbani et al., 2020; Wu et al., 2022; Yousaf et al., 2021).

Our course employs a range of teaching pedagogies to ensure that students gain a deep understanding of software entrepreneurship. Two key pedagogies are design thinking and collaborative learning (Akpan et al., 2023). Design thinking is a problem-solving approach that involves understanding the needs and desires of end-users. By teaching design thinking, students learn how to conduct user research, create prototypes, and test their ideas with real users, fostering a culture of innovation and encouraging creative problem-solving. Collaborative learning, on the other hand, encourages students to work together and learn from each other, developing essential skills such as communication, problem-solving, and project management.

By incorporating these pedagogies into our course, we create an engaging and effective learning environment. For instance, all ten class activities are conducted using collaborative learning, promoting a sense of community and encouraging students to support and learn from each other. Additionally, our course features guest lectures, maker education, project-based learning, and realworld applications, providing students with a comprehensive and well-rounded education in software entrepreneurship. By empowering students with the knowledge, skills, and mindset necessary to succeed in software entrepreneurship, we aim to contribute to the growth of the software industry in Saudi Arabia and support the country's economic development goals.

Maker education is a hands-on approach to learning that emphasizes building and creating products. In the context of software entrepreneurship, maker education can help students develop skills in programming, coding, and software development. By teaching students how to build and create software products, maker education fosters a culture of innovation and encourages students to think creatively about solving real-world problems. This approach also helps students develop a range of technical skills that are essential for success in the software industry.

Project-based learning is an effective way to teach software entrepreneurship because it allows students to apply their knowledge and skills to real-world projects. By working on real projects, students can develop a range of skills, including project management, problem-solving, and communication. Project-based learning also encourages students to think creatively about solving real-world problems and develops their ability to work independently and in teams. This approach can help students develop a portfolio of work that showcases their skills and abilities to potential employers or investors. The course has a comprehensive project that is delivered iteratively with several deliverables throughout the project.

Real-world applications are an essential aspect of teaching software entrepreneurship. By connecting the course material to real-world scenarios and case studies, students can see the practical applications of the concepts they are learning. This approach helps students understand how the concepts they are learning can be applied to real-world problems and how they can make a positive impact on society. Real-world applications also encourage students to think creatively about solving real-world problems and develop their ability to analyze complex situations and develop effective solutions. There are eight different detailed case studies from startups that were launched in Saudi Arabia.

Guest lectures are an effective way to teach software entrepreneurship because they provide students with insights and advice from experienced professionals in the industry. By inviting guest speakers to lecture on specific topics, students can learn from their experiences and gain valuable insights into the industry. Guest lectures can also provide students with networking opportunities and help them develop connections in the industry. This approach can help students learn about the latest trends and developments in the software industry and develop their understanding of the business side of software development. The course invited 4 different entrepreneurs and product managers from the industry to deliver these guest lectures.

The pedagogy of design thinking, collaborative learning, maker education, project-based learning, real-world applications, and guest lectures provides an

effective approach to teaching software entrepreneurship. By combining these approaches, students can develop a range of skills, including problem-solving, collaboration, technical skills, and entrepreneurial knowledge. This pedagogy fosters a culture of innovation and creativity, encourages students to think creatively about solving real-world problems, and provides them with the skills and knowledge they need to succeed in the software industry.

Figure 3 illustrates the learning process of software entrepreneurship, where students engage with the subject matter through a reproductive type of thinking. In this process, students receive information and problem-based training, which enables them to absorb and apply knowledge practically. The learning process begins with Explanatory and Illustrative Problematic Teaching, where instructors provide students with a comprehensive overview of software entrepreneurship concepts and principles. This is followed by Partial Search Engine and Research, where students are encouraged to explore and investigate specific topics and issues related to software entrepreneurship.

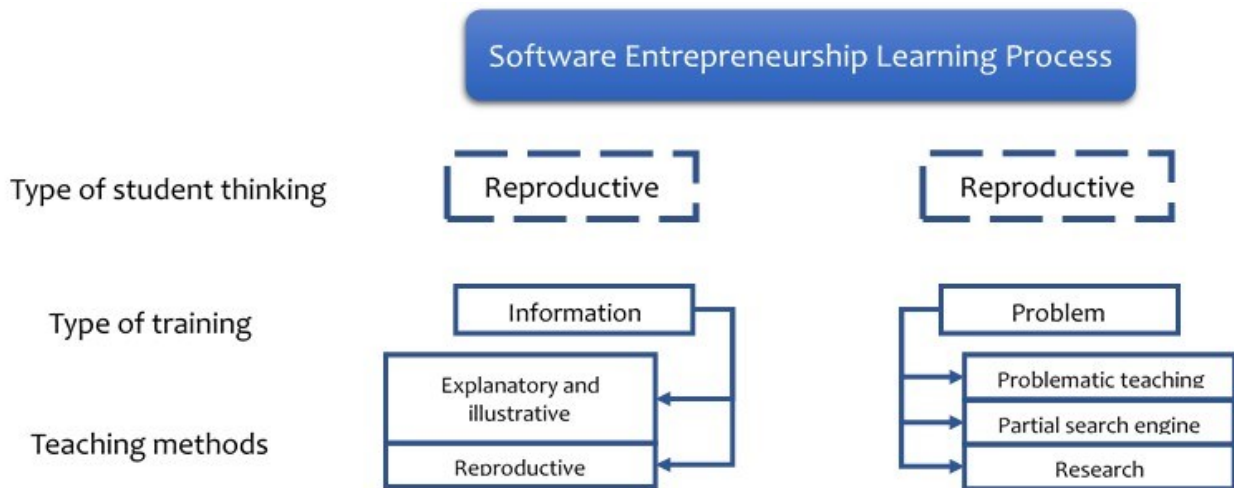


Figure 3. Software entrepreneurship learning process.

As students progress through the learning process, they develop a deeper understanding of the subject matter, which enables them to identify and analyze problems, and ultimately, develop innovative solutions. The reproductive type of thinking employed in this process allows students to absorb and apply knowledge practically, preparing them to succeed in the field of software entrepreneurship.

The reproductive learning approach is further divided into two types of training: information and illustrative. Information training involves the transfer of knowledge from teacher to student through lectures, readings, and presentations. Illustrative training uses visual aids, such as diagrams and videos, to help students understand complex concepts. The teaching methods used in reproductive learning are mainly explanatory and illustrative. Explanatory teaching involves the teacher explaining concepts and theories to students, while illustrative teaching uses visual aids to demonstrate how concepts work.

The problem-based learning approach, on the other hand, involves students actively solving real world problems to learn. This type of learning is more student-

centered and encourages critical thinking and problem-solving skills. The teaching methods used in problem-based learning are more interactive and hands-on, including prompt-based teaching, partial search engine, and research.

Prompt-based teaching involves giving students a prompt or question to guide their learning, while a partial search engine involves providing students with a limited amount of information to encourage them to search for more. Research involves students conducting in-depth research on a topic to find solutions to a problem.

Overall, the figure highlights the different approaches to software entrepreneurship education and how they can be tailored to meet the needs of different types of learners. By understanding the different types of student thinking and learning processes, educators can design more effective and engaging learning experiences for their students.

4. Discussion

The SE495 course model has significant potential for scalability and impact, not only in Saudi Arabia but also in other regions and educational contexts. The course's unique approach to integrating software engineering and entrepreneurship education can be adapted to address the specific needs and challenges of different regions and institutions.

The course has significant practical implications for the development of software entrepreneurship in Saudi Arabia. By equipping students with the necessary skills to develop innovative software solutions, the course has the potential to foster a new generation of entrepreneurs who can drive economic growth and innovation in the region. Moreover, the course's focus on solving real-world problems ensures that students are well-prepared to navigate the complexities of the digital and software sectors and to succeed in an ever-changing business landscape. As such, the course can play a critical role in supporting the Saudi government's Vision 2030, which aims to diversify the economy and promote private sector growth.

The study also has important theoretical implications for understanding software entrepreneurship education. By combining software engineering and entrepreneurship, the SE495 course challenges traditional approaches to software education, which often focus solely on technical skills. Instead, the course demonstrates the importance of integrating entrepreneurial skills and mindset into software education, to equip students with the skills and knowledge they need to succeed in the digital economy. Furthermore, the course's emphasis on user experience, market research, and pitching to investors highlights the need for a more holistic approach to software education, one that takes into account the social, economic, and cultural contexts in which software is developed and used.

At the end of the semester, both direct and indirect assessment methods are conducted to evaluate the students' achievements in relation to the course learning outcomes (CLOs). Below is an outline of how we assessed these outcomes:

- 1) Indirect Assessment (Exit Survey Results): Upon completion of the course, students were asked to complete an exit survey. This survey reflects their perceived achievement of the course learning outcomes. The results are as follows:

- CLO1: 4.8
- CLO2: 4.7
- CLO3: 4.72
- CLO4: 4.82
- CLO5: 4.81
- CLO6: 4.83

These scores are on a 5-point scale, with all CLOs being rated very close to the maximum, which suggests a high level of student satisfaction and perception of success regarding the intended learning outcomes.

2) Direct Assessment (Performance-Based Evaluation): Direct assessments were made based on students' performance throughout the semester, including their projects, exams, and assignments. The results are as follows:

- CLO1: 85.38%
- CLO2: 85.38%
- CLO3: 88.50%
- CLO4: 89.50%
- CLO5: 88.00%
- CLO6: 89.00%

The target threshold for each CLO was set at 75%. As evidenced by the results, all CLOs were achieved at levels significantly above the target, demonstrating that students not only met but exceeded the expected levels of performance. Together, these assessments provide both qualitative and quantitative evidence of the course's effectiveness in helping students achieve the learning outcomes. Based on this data, we believe that the course is successfully bridging the gap between entrepreneurship education and software engineering, as intended.

The study's findings have important implications for future research and development in software entrepreneurship education. Firstly, there is a need for further research into the effectiveness of the SE495 course, including its impact on student learning outcomes, entrepreneurial intentions, and startup success. Secondly, there is a need to explore the scalability and adaptability of the course, including its potential for adoption in other institutions and contexts. Finally, there is a need to develop new pedagogical approaches and tools to support the integration of entrepreneurship and software engineering education and foster a culture of innovation and entrepreneurship among students and faculty. By pursuing these research directions, we can continue to advance our understanding of software entrepreneurship education and support the development of a vibrant and innovative software industry in Saudi Arabia.

5. Limitations and future research directions

While this paper presents a promising approach to empowering software entrepreneurship in Saudi Arabia through the new elective course, there are several limitations to our findings that should be acknowledged. Additionally, these limitations highlight opportunities for future research and development in the area of software entrepreneurship education.

5.1. Single iteration and limited generalizability

Firstly, the course is an emergent topic elective course that has been offered for the first time, which means that our results are based on a single iteration of the course. Further research is needed to validate the effectiveness of the course over multiple iterations, different student cohorts, and varying instructor experiences. This would help to establish the course's long-term impact and identify areas for improvement.

Moreover, the design of the course was based on literature and best practices, but it has not been extensively tested or validated through empirical research. Therefore, our findings may not be generalizable to other contexts or institutions, such as different universities, countries, or cultural settings. Future studies should aim to replicate and adapt the course design in various settings to increase its external validity.

5.2. Limited dataset and feedback

Secondly, our study relies on a limited dataset, and there is a need to collect more evidence and feedback to improve the course further. Specifically, course exit surveys, student feedback, learning outcomes assessments, and guest speakers' feedback would provide valuable insights into the strengths and weaknesses of the course. Future research should aim to collect and analyze these data to refine the course design and delivery.

Additionally, it would be beneficial to conduct longitudinal studies to track the progress of students who have taken the course, including their entrepreneurial ventures, career paths, and impact on the Saudi Arabian economy. This would help to assess the course's long-term effectiveness in fostering software entrepreneurship and innovation.

5.3. Scalability and sustainability

Thirdly, the course's scalability and sustainability are crucial factors to consider. As the course grows in popularity, it is essential to ensure that it can be effectively delivered to larger student cohorts without compromising its quality. Future research should investigate strategies for scaling the course while maintaining its effectiveness, such as using online platforms, peer-to-peer learning, or instructor training programs.

Furthermore, the course's sustainability depends on the availability of resources, including funding, infrastructure, and industry partnerships. Future studies should explore ways to secure longterm funding, establish sustainable partnerships with industry stakeholders, and develop a robust ecosystem to support software entrepreneurship in Saudi Arabia.

By acknowledging these limitations and identifying opportunities for future research, we hope to encourage further development and refinement of the course, ultimately contributing to the growth of software entrepreneurship and innovation in Saudi Arabia.

6. Conclusion

Educating software entrepreneurs in Saudi Arabia requires a dynamic and practical approach that addresses the diverse needs of students, the community, and the university. By engaging students in the learning process and equipping them with

critical decision-making skills, educators can empower them to navigate the complexities of entrepreneurship and succeed in the digital and software sectors.

The course serves as a model for entrepreneurship education that prioritizes practicality and innovation. The course's unique approach, which combines software engineering and entrepreneurship, provides students with a comprehensive understanding of the software development process and its intersection with entrepreneurship. This approach ensures that students are well-prepared to develop software solutions that meet real-world needs and contribute to the growth of the Saudi Arabian economy.

Moreover, the course's emphasis on practicality and innovation aligns with the goals of Saudi Arabia's Vision 2030, which aims to promote entrepreneurship and innovation in the country. By equipping students with the necessary skills and knowledge to succeed in the digital and software sectors, the SE495 course plays a vital role in supporting the country's economic diversification and growth.

Furthermore, the course's focus on user experience and market research ensures that students are well-prepared to develop software solutions that meet the needs of the market and provide value to users. This approach helps to bridge the gap between academia and industry, ensuring that students are well-equipped to enter the workforce and make a positive impact on the economy.

In addition, the course's emphasis on collaboration and teamwork fosters a spirit of entrepreneurship and innovation among students, encouraging them to work together to develop creative solutions to real-world problems. This approach helps to build a strong entrepreneurial ecosystem in Saudi Arabia, where students can learn from each other and collaborate to create innovative software solutions.

Overall, the course offered serves as a model for entrepreneurship education in Saudi Arabia. By combining practicality and innovation, the course equips students with the necessary skills and knowledge to succeed in the digital and software sectors, contributing to the growth of the Saudi Arabian economy and supporting the country's vision for a more entrepreneurial and innovative future.

Author contributions: Conceptualization, MA (Mohammed Akour) and MA (Mamdouh Alenezi); methodology, MA (Mohammed Akour) and MA (Mamdouh Alenezi); software, MA (Mamdouh Alenezi); validation, MA (Mohammed Akour) and MA (Mamdouh Alenezi); formal analysis, MA (Mohammed Akour); investigation, MA (Mamdouh Alenezi); resources, MA (Mamdouh Alenezi); data curation, MA (Mohammed Akour); writing—original draft preparation, MA (Mamdouh Alenezi); writing—review and editing, MA (Mohammed Akour); visualization, MA (Mamdouh Alenezi); supervision, MA (Mamdouh Alenezi); project administration, MA (Mohammed Akour). All authors have read and agreed to the published version of the manuscript.

Acknowledgments: The authors would like to acknowledge the support of Prince Sultan University for paying the Article Processing Charges (APC) of this publication.

Conflict of interest: The authors declare no conflict of interest.

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