# Teaching Programming Blockchain Applications to undergraduate students

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**Abstract.** Blockchain is a technology with potential for supporting industrial applications with traceability and transparency. Unfortunately, the understanding necessary to make decisions regarding the adoption of the technology and to implement blockchain-based applications is still in short supply.
We have designed and taught for two years an undergraduate course to help filling the talent gap that is undermining Blockchain adoption. The course is thought as a hands-on course, where students gain initial skills in developing supply management applications for the BSV blockchain. This paper describes the motivations and challenges of the course, discusses its main achievements and issues, and suggests guidelines to follow based on our observations and the student feedback.

**Keywords:** blockchain, education, experiential learning, employability, supply chain management

## 1 Introduction

Blockchain is an emerging technology with the potential to transform the way businesses and financial institutions process transactions. Embedding user-defined information within blockchain transactions allows for new ways of publishing and exchanging information among stakeholders, enabling transparency, traceability, cost-efficiency, and trust.

A wide range of industries, including banking, healthcare, infrastructure, travel, and others, could potentially be disrupted by adding blockchain technology to applications such as asset tracking and inventory management [5]. But despite the expectations and endorsements (Garner claimed in 2022 that *"now is the time to act"* [9]) blockchain remains a developing technology. The steep learning curve has played a relevant role in the shortage of professionals with blockchain-based application development skills and, in general, with the needed expertise, which is undermining its adoption [23]. To tackle this problem, technology companies, universities, and other entities are offering educational programs [23, 7, 30]. Fortunately, students are interested in the technology, motivated by the cryptocurrency hype and the high salaries blockchain developers receive [23].

At Molde University College we have taught for two years the undergraduate subject "IBE500 Programming Blockchain Applications" as an elective course for the bachelor in Information Technology and Digitalization (ITD) students. With that, we intend to fill the skills gap by introducing students to blockchain concepts and enabling them to design and implement software applications that use the blockchain, with a focus on Supply Chain Management applications. Our course is not so much about technology details, but on providing the students with the tools to determine when a blockchain-based solution is the best alternative for the problem at hand and how to implement such an application if that is the case.

Connecting companies with universities through this technology can improve the employability of students. This approach provides students with relevant experience in line with industry requirements, while also allowing them to develop essential networking skills [26]. The course was developed in close collaboration with local companies and blockchain specialists, ensuring that it meets the most up-to-date knowledge and skills, meets industry needs, and provides our students with realistic use cases. This approach is crucial for delivering a high-quality educational experience that prepares them better for a successful career. This paper aims to help fill the talent gap that is undermining blockchain adoption by addressing the research question: *How should a higher educational institution teach programming of blockchain applications to undergraduate information systems students?*

To investigate this question, a case study approach was adopted as the primary research method [29]. The case study method focuses on the exploration of a particular phenomenon, rather than identifying the cause and effect. The case study approach is being widely used as a common research strategies it has the potential to make unique contributions "to our knowledge of individual, organisational, social, and political phenomena" [29]. The unique characteristic of the case study approach is the ability to acquire and "retain the holistic and meaningful characteristics of real-life events" [29]. In particular, we used an explanatory case study to collect and examine the data carefully supporting explanation of the phenomenon. Data were collected by (1) a review of a key stone blockchain application programmed by the students on the request from business companies, (2) by logs of discussions with with students via on-line forums (Discord, Canvas, e-mail), and (3) by data from mandatory assignments and the final exam. The data were analyzed to explain the challenges of teaching blockchain application programming.

The remaining parts of this paper are Section 2 describing challenges and motivations leading to the ideas and design decisions explained in Section 3. Based on the pieces of evidence collected from our observations, the assessment results, and the opinion of the students (via emails and the evaluation kit), we analyze in Section 4 what worked well and what didn't work so well. Section 5 states our conclusion.

## 2 Challenges in learning and teaching blockchain technologies to undergraduate students at Molde University College

This section describes the challenges in learning and teaching blockchain in general and in particular in our context and reviews different blockchain course programmes and subjects syllabus, as well as curriculum recommendations.

### 2.1 Challenges in learning and teaching blockchain technologies

Teaching and learning blockchain technologies is difficult. As an interdisciplinary technology, learning blockchain involves understanding several topics and their intersections, including game theory, distributed systems, laws and regulations, computer science, and finance and accounting. Further understanding of areas such as computer security is necessary to identify whether the technology is appropriate for a specific context. Moreover, software design and development skills are required to implement blockchain-based real applications.

While learning about this many subjects contributes to the so-called "interdisciplinary competence" [8], teaching and learning all the blockchain-related foundations and skills during a single term is unfeasible. Instead, the intended learning outcomes (ILO) are customized to reflect the desired competencies for the course based on the program curriculum, which depends on several factors, such as [19, p. 74]:

- The type and expectations of the institution.
- The range of postgraduate options that students pursue.
- The interests and expertise of the faculty. This is related to the postgraduate options mentioned above, especially in small faculties.
- The preparation, background, and motivation of the students.
- The faculty resources available to the institution.
- The job market demands, with emphasis on local needs.
- The degree of the program.

Whether the course studies how to build a blockchain or how to use it, focuses on the cryptocurrency aspects of the technology, studies and implements smart contracts, gives a broad overview of several blockchain types and platforms, or, instead, illustrates the foundations with a specific blockchain, is deeply connected with these factors. Indeed, courses with different objectives focus on very different aspects of the technology [30].

For instance, the Sloan School of Management at MIT offers the online course for entrepreneurs "Blockchain And Money" [10] for students wishing to explore the potential use of the technology. The course provides an understanding of the commercial, technical, and public policy fundamentals of blockchain technology, distributed ledgers, and smart contracts. The course also reviews the potential blockchain applications in the financial sector, along with the markets and regulatory landscape for cryptocurrencies. The assessments are based on individual write-ups and a group research paper.

On the other hand, the undergraduate Computer Science course "Blockchains, Cryptocurrencies, and Smart Contracts" offered at Cornell University [18] explores Bitcoin and its underlying mechanisms including consensus algorithms, cryptographic tools and applications including digital signature algorithms and zero-knowledge proofs, and smart contracts. The prerequisites are a good level of programming experience, the ability to deal with challenging programming tasks, familiarity with common algorithms and data structures, and a basic understanding of discrete mathematics.

The Hong Kong Polytechnic University has created a Master of Science in Blockchain technology associated with their Research Centre for Blockchain Technology (RCBT) [25]. The programme includes the subjects Blockchain and Smart Contract Security, Distributed Ledger Technology Cryptocurrency and E-Payment, Distributed Algorithms and Protocols for Blockchains and Cryptography and Blockchain, as well as Information Technology subjects such as Database Systems and Management, Data Analytics, Wireless Networking and Mobile Computing, Artificial Intelligence Concepts and Cyber and Internet Security. The objectives of the course are to produce graduates with specialized knowledge in blockchain technology who can apply emerging technologies to solve problems in the financial sector. The program is suitable for students with little or no computing experience in academia as well as for computer science graduates. Moreover, the school offers the course "E-Payment and Cryptocurrency" as part of the Bachelor of Science program. The subject ILO are: to acquire a fundamental understanding of cryptocurrency and e-payment; to evaluate cryptocurrency and e-payment systems, applications, and protocols; and to design and implement cryptocurrency and e-payment systems/applications [24]. This course studies the fundamentals of payments and includes a module dedicated to Bitcoin (and its variants, e.g. Litecoin) and other crypto-currency systems (e.g. Ethereum, Monero, ZCash). Practical courses are more easily associated with industry partners. A connection with the industry should be created both as a motivation and as a means to improve students' employability while leveraging the specific needs of the local industry. Yorke and Knight [16] have discussed how to embed employability into the curriculum. We are interested in blockchain as a tool that might add value to industry applications. However, many students are more interested in the cryptocurrency aspect of the blockchain.

The curriculum must account as well for the frequent technology changes in an emerging technology. As an emerging technology, there are still many unresolved issues, and changes happen quickly. It is difficult for educators to have a grip on the details of the technology and to keep updated [6].

Because technology advances rapidly, we are interested in developing a foundation by promoting a deep understanding of the principles. However, some students take a surface approach to learning, that is, the student is not searching for meaning when engaging in a learning task [20]. Instead of understanding, the student is focused on performance through remembering and treats the task as an imposition. On the other hand, adopting a deep approach allows one to reach the highest levels of Bloom's Taxonomy [2]. According to Bloom's revised taxonomy, learning starts by creating a foundational basis on the "Remembering" level and continues through "Understanding", to the higher level orders of thinking "Applying", "Analyzing", "Evaluating" and "Creating". Promoting student engagement and collaboration and maintaining regular communication with the students may motivate students to assume an active learning posture.

### 2.2 Challenges in our context

The course has been offered for two years at the Molde University College for students of the Information Technology and Digitalization bachelor and free-standing students as a 7.5-ECTS elective course. The 2017 Information Technology Curricula Report [19] states that Information technology specialists should be aware of current emerging technologies, and be able to identify their effects on IT. As such, the course should provide the students with technologically up-to-date skills that enable their insertion into the job market.

Our students have heterogeneous programming skills and motivation degree. The bachelor in IT and Digitalization programme at Høgskolen i Molde doesn't include courses on computer networking, distributed systems, or JavaScript. In consequence, the students lack the necessary background they need in this course, which must be provided in advance.

Our college offers hybrid courses for face-to-face and online students. That allows remote students to attend our courses without leaving their homes. During the COVID-19 pandemic, the school lectures became online lectures and the assessments turned into online, non-proctored home assessments. A common issue in a hybrid setting is how to deal simultaneously with two different learning contexts: face-to-face and online, and how to interact with them in real time.

Currently, the exams are again written exams. The course mandatory assignments do not affect the final grade but are required for the student to take the final exam.

### 2.3 Design decisions and syllabus

The first edition of this course was offered as a mandatory course, with an initial enrollment of more than 80 students, lectured in Norwegian and English by two professors. The course was designed from the start as a practical subject. The objectives of the course were aligned with those of the bachelor program, as it helps students to develop technology skills in high demand in today's job market. By the end of the course, the students would be able to write into and retrieve data from the blockchain. A connection with the industry -preferably a local industry- should be created both as a motivation and as a means to improve students' employability while leveraging the specific needs of the local industry [16] has discussed how to embed employability into the curriculum.

This motivates the inclusion of practical activities in our curriculum. This can also be justified in light of Kolb's experiential learning framework [14]. According to Kolb, individuals can engage more effectively in learning through the application of a cycle of four stages, shown in Figure 1. The problem of student engagement has been largely discussed in literature [27]. The role of the educator goes beyond the subject-knowledgeable person to the creation of an environment of trust where students are engaged to participate and communicate with the teacher and among themselves. This task can be more or less difficult according to the local culture, age, and digital background of the target group. This is also related to the approach to lecturing: discursive-like lectures are prone to more of a passive audience while active lectures aim to promote action and participation of the student in the learning process. The introduction of practical activities yielded the prerequisite for a basic prior knowledge of computer programming.

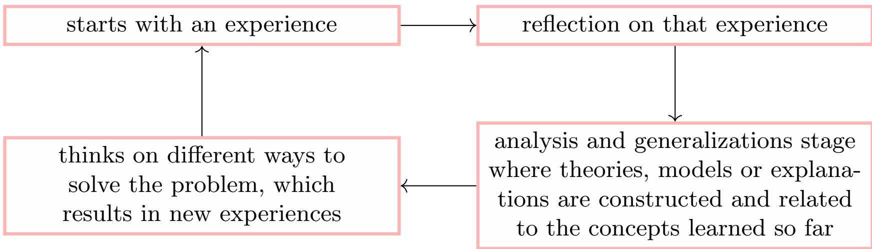


**Fig. 1.** Kolb's Experiential Learning Cycle

Experiential learning allows the integration of real-world experiences into learning, improving employability and student motivation. Students learn how to deal with real problems and how to work in teams. They have the opportunity to apply what they learn while building portfolios that illustrate their skills. Industry has the opportunity to see what's done in the universities.

The educator must provide activities that allow the students to achieve the expected learning outcomes. Designing a course from the learning outcomes rather than based on content makes it easier to connect the topics in the course, balancing the load in each module, and more importantly, relating the assessments with the learning outcomes, as suggested by the constructive alignment theory [4]. This promotes consistency between the components of curriculum design (learning outcomes, teaching activities, and assessments) to enable the learners to construct knowledge.

Students learn through investigation or inquiry during the projects and on activities that ask them to go beyond the essential readings to satisfy their curiosity on a topic. This approach also encourages learning through production, as they are required to produce concrete material as a result of their work. When students perform these activities as a group, they can also learn by collaboration and discussion. Indeed, activities that promote discussions can encourage reflection and abstract conceptualization of ideas and observations. By engaging in such activities, students can move through the learning cycle and reach higher levels in Bloom's taxonomy. A high degree of interaction between students and educators has a positive impact on student outcomes, in particular in online courses [17].

However, promoting collaboration among on-campus and online students is not that simple. Structures, frameworks, and scaffolding should be provided to the students to help them make sense of their learning and what they are expected to do [3]. An inspiring model is Salmon's five-stage-model [21]. That model provides a framework for structuring online activities. The model specifies the support and components needed for the participants to engage in activity at each stage. Depending on the stage, the e-moderator provides support and motivation, designs good online activities, and gives them feedback. The support decreases as they evolve, while the complexity of the activities increases. While the model is made thinking in an online and blended setting, we find it useful as well for the development of face-to-face courses in collaborative, active environments. It calls for scaffolding, or carefully preparing the conditions for student engagement, starting by initially getting them used to the environment, socializing with teacher and peers, and then the gradual introduction to the environment and the construction of knowledge with the result that the learner becomes more and more autonomous and independent, which allows to reduce the support needed. Still, it is necessary to verify how this idea would work in the context of a large classroom, with students with different backgrounds, needs, and availability.

The success of this approach relies both on the design of the activity and on the feedback received by the student.

*Assessments and Feedback*

The inclusion of professional practice in course assessments and activities that meet the needs of the industry to make sure students acquire professional competencies are among the elements that the ACM IT curriculum report [19] recommends from learning environments that support students in acquiring professional practice competencies.

Since performance goals can promote surface learning, switching to formative (instead of summative) assessments with questions designed for understanding, and accurate and prompt feedback might engage students in a deeper approach to learning. However, some students tend to ignore exercises that are not mandatory.

Students need support while performing meaningful activities in a complex subject. The kind of support and the timing are variables that affect the effectiveness of feedback [11]. It requires not only subject-specific knowledge but also patience and sensitivity to create a friendly climate, and good timing to avoid frustration. Teachers and assistants need to be prepared in advance to give timely and effective feedback. This increases the skills required from the Teaching Assistants, a position already difficult to fulfill. Indeed, finding teaching assistants that are knowledgeable in the subject was difficult in the first edition of the course, and didn't become substantially easier afterward.

Good feedback allows reducing the discrepancies between current understanding and performance, and a goal [11]. While formative assessments are recommended because of the chances for feedback and the lack of performance pressure it is a common issue that the student tends to skip the formative and not compulsory tasks. Compulsory assessments are not a consensus among students [15] but have the advantages of supporting students to keep up with the course (or should) and allowing for frequent and timely feedback. Nevertheless, they can be a hurdle for students who require a flexible schedule, such as students in the military or working in oil rigs.

## 3 Course design: exploring solutions to the challenges

Our aim was to design a course that is foundational, but also provides real experiences with the blockchain and enhances employability in connection with local industry. With that in mind, the course was organized around the following learning goals:

- Foundation: cryptographic hash functions, public key cryptography, digital signatures, client-server and P2P architectures.
- Blockchain basics: The Satoshi white paper. Core concepts of a blockchain and mining: transactions, UTXO, scripts, blocks, consensus, economic model, and network structure.
- Hands-on activities with the goal of teaching how to write and retrieve information from a real public blockchain increasing complexity progressively.
- Blockchain and the supply chain: Analyze and propose blockchain-based solutions to real supply chain problems brought by industry stakeholders.

### 3.1 The course as taught in 2022

Lectures were synchronous, online, and discursive and were recorded and made accessible to all students in Canvas. The exam was also online.

The problems discussed in the course were related to the Fish-tracing problem [12] and the carbon footprint.

One of the most important resources provided by the BSV ecosystem [1] is WhatsOnChain.com. Whatsonchain BSV explorer and API provide access to transactions and blocks history, allowing to verify the history of transactions and success of operations executed on the blockchain, as well as straightforwardly examining blocks and transactions and broadcasting new transactions.

The main book in the course was Bitcoin Blockchain: Protocol for Micropayments [13]. Together with the book, we also used the courses provided by the BitcoinSV Academy [1], Satolearn.com, and the BSV Wiki.

Teaching and learning methods: 3 hours of lectures in a row per week and weekly practical compulsory exercises with support by email and Discord.

The exercises build on previous content and the level of difficulty was increasing. Examples of exercises include:

- Write a program in Node.js, or use the one given, to compute the SHA-256 hash of all numbers from 0 to 1000000000 until the goal is reached, that is, a digest starting with one 0 is found. Then the program prints the number and the hash, and exits. Repeat the execution, each time increasing the number of 0s to be found 1 at a time. At the last iteration, a hash starting with at least 8 zeros should be found. Make a note of the execution time of each run. What conclusion can you draw from your results?
- Generate and store a key pair
- Create a transaction to send money to your Handcash account and broadcast it to the testnet blockchain using WhatsOnChain. When done, look it up on WhatsOnChain. Check in WhatsOnChain your transaction and in HandCash that you received the change appropriately.
- Create and broadcast a transaction to BSV to record a sentence of your choice. To broadcast the transaction you can use the WhatsOnChain explorer link https://test.whatsonchain.com/broadcast
- Deliver a UML Use Case Diagram of a blockchain-based solution for both cases

After the first edition, we found it necessary to review some aspects of the course. Based on our experiences and the feedback from the students, we implemented the following modifications:

- To offer a crash course in JavaScript and asynchronous programming.
- To turn to flipped classrooms and organize hands-on lectures/labs for the programming part. This would allow students to get a grip on the theory before coming to class to discuss and solve the programming assignments with TAs and teacher support. Some students related their inability to ask questions about code during the lectures, the questions usually arise while they are trying to solve the practical assignments.
- To find a better balance between theory and practice throughout the course;
- To provide better support for assignments;
- To divide the Capstone assignment into several smaller assignments;
- To turn the subject elective;
- To promote a pragmatic view of the platform, including discussions on the environmental, social, and economic impact of the platform for sustainable development.

## 4 Discussion

The feedback from the students allowed us to correct some issues during the first edition. Still, there remain problems that are expected to be corrected in future editions.

Providing practical activities doesn't necessarily mean that deep learning and therefore the highest levels of Bloom's taxonomy [2] will always be reached. To leverage the power of the reflection and abstract conceptualization stages in Kolb's learning cycle, open-ended questions were included to document the programming activities.

The following questions are related to the stages that follow the concrete experience [28]:

**Reflection** What just happened? What patterns are evident? What were the significant aspects of the experience?

**Abstract Conceptualization** What are the underlying principles of my experience? How based on the theory studied can I justify what I have just experienced?

**Active experimentation** How does my knowledge apply to other situations? What are the consequences in other settings? How will I implement (have I implemented) my new knowledge?

### 4.1 Bitcoin SV

Bitcoin SV was a good choice as a blockchain use case both in terms of theory and its components and functionalities. Combined with open open-source Node.js libraries available, it allowed the students to implement relatively simple code that interacts with the blockchain. The advantages of BSV include: (i) Node.js libraries available (ii) free and accessible support (iii) closer to the original Bitcoin protocol (iv) low transaction fees and high throughput (v) support for smart contracts, but simpler than Ethereum.

However, the lack of Node.js BSV libraries' updated documentation made the task of supporting students more laborious. Several tools developed for BSV in the past that could have been useful for this course are no longer maintained. More appropriate literature on blockchain-related to supply chain management needs to be provided. The documentation of libraries we used for the implementation is incomplete or outdated.

On the bright side, we received invaluable support from professionals who are already working on using blockchain in industrial applications and companies interested in blockchain-based solutions. This support allowed us to implement our plan of delivering a hands-on course on blockchain-based industrial applications. A shortcoming of having only technology supporters as guest lecturers is that we missed opportunities to discuss negative aspects of the technology, as pointed out by student feedback. This may give the wrong impression that the platform has no areas in need of improvement.

WhatsOnChain was essential both as a teaching aid and a troubleshooting tool. In lectures, it allows for visualization of the transaction components and helps to get a better understanding of how transactions and blocks are related.

The testnet provided a free and safe environment for developing and testing, along with the faucets that deliver testnet bitcoins on demand.

The resources provided by the BSV Academy are useful and informative, but while their courses are linear, we need to have punctual access to particular topics instead. The book contains chapters with descriptions of tools that are no longer supported.

## 5 Lessons learned

When we started working on the design of the course, our main concerns were that: (i) the blockchain technology is very difficult to understand, (ii) it has too many areas involved, (iii) this was an introductory course taught to students with diverse interests and programming backgrounds. The course was organized around the idea of teaching the students the fundamentals necessary to understand blockchain technology and to implement small applications that write and retrieve information from the blockchain. The focus was not on cryptocurrencies but on the potential of blockchain-based solutions to solve real business application problems -specifically SCM problems- that are difficult to overcome otherwise. To that end, real use cases were presented by invited guests from the industry, who discussed issues they currently face, for which the students proposed solutions based on blockchain.

The hands-on prompted the students to review the theory, and demonstrated the theory in practice, reinforcing their understanding of the theory. Having the students modify or write small programs was the solution found for their heterogeneous programming background to make the activity available to everyone. Still, an initial course in JavaScript and asynchronous programming would have lowered the learning curve remarkably, very likely also enhancing retention.

Bitcoin's inherent interdisciplinarity, the complexity of the principles underlying Bitcoin, and our students' background more focused on logistics than in computer science, were the main challenges during the preparation of an introductory course on Bitcoin. Combining theory with programming experience and interactive support proved to be effective in terms of student learning. Based on Kolb's learning cycle, each assignment required the students to use and sometimes modify chunks of code explained during the lecture. This method alleviated the requirements for a strong programming background while allowing the students to reach higher levels of the Bloom Taxonomy.

Our students needed support along the way, both in the theoretical and the practical assignments. Discord proved to be very useful, allowing us to interact with the students in real time using several multimedia resources, including syntax highlighting support. This was even more useful when the interaction happened in public channels that the other students could see and to which you could refer to for late students. However, due to GDPR restrictions, the use of this tool has been halted at school.

Discussing theory and code with the students on the public Discord channel was a positive experience because the interactivity the platform provides helped solve their issues faster and other students could also benefit from the discussions. This year, with the return of face-to-face lectures, this issue was not so relevant.

As expected of a first edition of a course of this complexity, we had to face countless issues. The BSV-based business applications developed used successfully the blockchain for data only, i.e., store off-chain data on-chain, and fetch on-chain data and store them off-chain. However, the Bitcoin SV libraries are currently not well documented and lack support. Preparing for class and helping students with debugging their code was a demanding task that required a significant amount of effort, including understanding all the details and having the necessary code prepared beforehand. The unavailability of alumni with knowledge in blockchain to work as TAs further exacerbated this issue. This shortage of knowledgeable TAs also had a negative impact on the quality of feedback provided to students and ultimately impacted their ability to learn effectively.

Our exam results seem encouraging. However, it is necessary to review some aspects of the course. Based on our experiences and the students' feedback we suggest the following modifications:

- To improve the learning material. We are currently working on that direction in collaboration with the BSV Academy.
- No smart contracts were involved in this course. This material is considered advanced, but due to the interest of the students it should be progressively integrated into the content in future editions.
- A relevant topic is compliance. In that aspect, a discussion on whether blockchain applications remain a suitable tool after the EU data protection law should be in place [22].
- There is a tendency to move from JavaScript to Golang. If this becomes a trend in BSV changing the course programming language may be necessary.

## 6 Conclusions

Blockchain technology has potential to improve the way businesses interact. This paper has presented an evaluation of two editions of the course "IBE500 Programming Blockchain Applications" offered to students of a bachelor in IT and digitalization. This evaluation was made as part of the end of term iterative refinement of the syllabus content. A critical review of the motivation, challenges, findings, achievements and remaining issues was presented, and a syllabus for a similar course was proposed. The use of the BSV-blockchain turned out to be significant for implementing implementing experiential learning. Notable BSV features in this regard are low transaction costs, good from BSV Academy, available source code on GitHub for accessing the blockchain since books and learning materials are partly obsoleted, and its implementation is close to the original blockchain with the unique features described in the white paper. We found that the contact with companies were fundamental to motivate students, since it expands the students perspective and made them address problems relevant for their employability. Our university is a specialized university in logistics (supply chain management), a field having many problems that potentially can be addressed by blockchain technology.

A major challenge was the students' lack of time to work on in-dept issues since the blockchain-course is 1 out of 4 courses in the spring semester.

The course goals were defined as introducing the students to the fundamentals of the blockchain, how it can be embedded into existing business applications, particularly supply chains, and the advantages and disadvantages of this approach. Students interested in blockchain application programming can, after this course, pursue more advanced studies.

Lastly, we call for future research on how to teach blockchain application programming especially on: - how to bring this technology undergraduate students, - how to increase the availability of professionals who understand the blockchain principles, - how to support business decisions on when blockchain is the right match for their application needs, - doing comparative analysis of several teaching methodologies, - conducting more case studies on teaching blockchain application programming at other institutions to get a wider set of experiences, - the more general challenge of teaching courses on new technologies, - comparisons on the results with theories to strengthen, eventually, expanding the theories, - evaluating and selecting frameworks for building such a course.

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