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Topics of Blockchain Technology to Teach at Community College

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***Abstract*—**Blockchain technology has rapidly gained popularity in industry. This paper attempts to assist academia to answer four questions. First, should community colleges begin offering education to nurture blockchain-literate students for the job market? Second, what are the appropriate topical areas to cover? Third, should it be an individual course? And forth, should it be a technical or management course? This paper starts with identifying the knowledge domains of blockchain technology and the topical areas each domain has, and continues with placing them in appropriate academic territories (Computer Sciences vs. Business) and subjects (programming, management, marketing, and laws), and then develops an evaluation model to determine the appropriate topical area for community colleges to teach. The evaluation is based on seven factors: maturity of technology, impacts on management, real-world applications, subject classification, knowledge prerequisites, textbook readiness, and recommended pedagogies. The evaluation results point to an interesting direction that offering an introductory course is an ideal option to guide students through the learning journey of what blockchain is and how it applies to business. Such an introductory course does not need to engage students in the discussions of mathematics and sciences that make blockchain technologies possible. While it is inevitable to brief technical topics to help students build a solid knowledge foundation of blockchain technologies, community colleges should avoid offering students a course centered on the discussion of developing blockchain applications.

***Keywords*—**Blockchain, pedagogies, blockchain technologies, blockchain course, blockchain pedagogies.

I. Introduction

THE fast-growing demand of blockchain-capable workers has created a talent shortage, and academia of all levels should start finding ways to fill the talent gaps. Yet, is blockchain a competency-appropriate technical topic for students of community college?

In a nutshell, blockchain is a decentralized, secure digital ledger. It is the underlying technology of the globally recognized cryptocurrency, Bitcoin, and is used by Bitcoin for governing all transactions. As defined by Don Tapscott, co-founder and executive director at the Blockchain Research Institute, blockchain is "an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value" [10]. Blockchain is a digital mechanism that enables people who do not know each other to engage in trusted transactions with full confidence in the integrity of the assets being exchanged. It has been used to transform financial services, reactivate the booming IoTs (Internet of Things), secure transaction records, and resolve privacy issues. Traditionally, electronic transactions require a trusted third party such as banks, governments, notaries, and accountants. Blockchain can eliminate these middlemen to improve the transaction efficiency at lower cost. Blockchain-based applications may also enhance the IoTs [15]. In search of answers, the author proposes to evaluate the appropriateness from seven aspects, as listed in Table I.

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TABLE I
Evaluation Criteria

Aspect	Definitions
Technology Maturity (TM)	The level of readiness of blockchain technology for solving real-world business problems.
Impacts on Management (IM)	How blockchain has affected and changed the management practices.
Real-World Applications (RA)	The use cases of blockchain in industries.
Subject Classification (SC)	The category and classification of blockchain in college-level of education by subjects, business, computer science, law, or a new subject by itself?
Knowledge Prerequisites (KP)	The knowledge and skills required to learn and comprehend concepts and technologies of blockchain.
Textbook Readiness (TR)	The availability textbooks and/or reference book of blockchain.
Recommended Pedagogies (RP)	The appropriate teaching methodology suitable for dissemination of knowledge and skills of blockchain.
Instructor Pool (IP)	The level of difficulty to find qualified instructors.

The next sections will discuss these aspects in detail to provide a foundation to rate the topical areas of that are addressed by currently available college-level blockchain courses. Then, draw a conclusion based on the results of evaluation.

II. Technology Maturity

Blockchain is built on top of a peer-to-peer network; however, it is a collaborative effort among multiple entities to strive for management of decentralized, transparent, cross-border, tamper-proof, and trusted records. The bare minimum technology is a set of: (a) smart contracts, (b) a cryptographic algorithm, (c) APIs to payment systems (such as the API released by Mastercard), (d) a decentralized network, and (e) an open blockchain.

IBM, Oracle, and SAP are probably the three largest players in the business application domain of blockchain technology [3]. J. P. Morgan Chase, SWIFT, Microsoft, and Accenture are active players of blockchain, too [2]. Ever since its first realization made by the legendary Satoshi Nakamoto (possibly a pseudonym) in 2008, exciting blockchain technologies were introduced constantly; all these blockchain players are competing towards global implementation of blockchain

technologies at full speed. However, blockchains have some shortcomings that still need to be resolved. First, it has limited scalability. While the Visa network is capable of processing at least 40,000 transactions per second, Ethereum and the Bitcoin blockchain are capable of processing approximately 15 and 7 transactions per second, respectively [9]. Second, the adoption of a universal browser-based API is born but still needs greater collaboration among all browser makers including Microsoft, Google, Facebook, Apple and Mozilla [4].

On the other hand, blockchain has shown some maturity for supply chain management and the technologies have been implemented in some industries with the "Hyperledger" platform which is a technology more suitable to building business applications [3]. In the marketplace, many enterprise platforms including Ethereum, Hyperledger, R3 Corda, Ripple, Quorum, and others are readily implemented, while the Blockchain Interoperability Alliance was formed in 2017 facilitating interoperability. It is reasonable to say that blockchain seemingly will not reach the maturity phase soon, but its technology surely is not in its infancy any longer and has reached a point that actual enterprise implementation is made possible by collaborative efforts. There are still challenges associated with blockchain, but the challenges are less technical [3]; therefore, academia should not overlook blockchain.

III. Impacts on Management

The introduction of blockchain has significantly impacted many industries including finance, real estate, retail, healthcare, arts and entertainment, government, legal, food, energy, hospitality, education, insurance, and many others. The impact is not limited to domestic enterprises, but global industries.

From the management's perspective, the critical impacts are the competitive implications and business opportunities associated with how blockchain is affecting operations like supply chain, smart contract, and record management as well as processes to authenticate intellectual property, secure transaction records, and resolve privacy issues. Reference [14] describes how blockchain technology can apply to supply chain optimization to enhance logistics and distribution in a mega city. Since blockchain can significantly lower the cost of digitized operations with higher efficiency, it has begun reshaping the organizational structure of enterprises to maintain competitive advantage. Table II is a sample list of impacts that should be deeply addressed and reviewed.

TABLE II
Impacts on Management

Topical Area	Description
Transaction Processing	Managing regulated currencies (like US dollars), financial instruments, and derivative contracts with a shared, flat ledger managed by a trusted processing node.
Operation Management	Optimize supply chain, reduce risks in sourcing and category management, and increase transaction transparency.
Record Management	Secure and authenticate intellectual property at lower cost and higher efficiency.
Organizational Structure	Organizations will move from hierarchical structure to non-centralized structure with less in-house manpower-intensive jobs and more loosely-bonded information workers.
Secured Trading Platform	Companies of all sizes can issue "tokens" (like stocks for investors to buy and sell) to raise funds for business operations in a transparent platform that is open 24/7 for trading with low fees.
Digital Marketing & Strategy	Blockchain builds public accountability to eliminate the need of digital middlemen and give control over sharing their information.
Media Management	All media, particularly social media, are working on using blockchain to resolve the worsening "fake news" issue.
Implementation Strategies	All tech-related projects are facing the challenge of timing, and so is the implementation of blockchain. Enterprises need to evaluate how agile methodology and its related models could possibly contribute to the rapid implementations.

Even when the blockchain technologies, particularly distributed ledgers and smart contracts, have evolved into a practical operation-optimization mechanism, how an enterprise can embrace the power of such technologies remains an important business-centered topic. Before massive corporations, including Walmart and Amazon, announced their blockchain projects, all levels of management, from executive to operational, need a non-technical overview to understand how blockchain technologies work in an enterprise business environment.

IV. Real-World Applications

Blockchain is the technology that powers Bitcoin, yet is not designed for Bitcoin. Blockchain technology is useful in a large variety of business scenarios where digital consensus and a distributed ledger can help to secure transaction settlement and reduce costs. In addition to decentralized cryptocurrencies like Bitcoin and Ethereum, blockchains have been used for smart contracts [14], enforcing healthcare and medical records to comply with privacy requirements of HIPAA rules [12], enabling identity owners to control personal information through the digital identity management [6], and protecting records of artist ownership, royalty, and distribution in the music industry [8]. Marketing could use the technology as well. It can remove the intermediary and middleman from digital advertising. Initially, the transparency of blockchain can build a trust relationship between the brand owners and their customers. A blockchain-enabled customer relationship management has the ability to process every step of customer claim with transparency, because all steps in the process can be openly analyzed and validated; therefore, it could eventually lead to a more mutually trusted environment for negotiating and approving contracts without the need of notary [5]. Furthermore, the advertisers can see exactly where their target audiences are going. Accounting can use it for invoice reconciliation. Financial institutions, particularly

banks, are also implementing the technology for: (a) asset management for trade processing and settlement, (b) insurance claim processing, and (c) cross-border payments [7]. In the next few years, the education industry will use blockchains to validate student records including identity, grades, transcripts, student loans, and any other digitized records [11]. All the above mentioned, "use cases" imply that blockchain could apply to all digital records in almost every sector and industry in the real world.

V. Subject Classification

Academia is not slow in responding to the rise of blockchain. As of the time of writing this paper, top-ranking universities like Duke, UC Berkeley, Carnegie Mellon, and Princeton offer blockchain-related courses; however, there is not yet a consensus about which subject area blockchain should be categorized. For example, UC-Berkeley offers a course titled "Blockchain, Crypto-economics, and the Future of Technology, Business and Law" which is cross-discipline course that teaches how blockchain brings opportunities at the intersection of technology, business and law. This could be the first course cross-listed in three departments: engineering, law and business. The University of Southern California offers a blockchain course from its School of Engineering as an introductory course that covers basic blockchain technologies and applications. The Department of Electrical and Computer Engineering of the University of Illinois offers a technical course that focuses on the discussion of Smart Contracts and Blockchain Security. A preliminary research conducted by the author found two common alternatives: business and computer science. At a community college that has both Business and Computer Information System (CIS) departments; Fig. 1 illustrates how the authors classify topics of blockchain for the sake of evaluation (as shown in Table III of a later section).

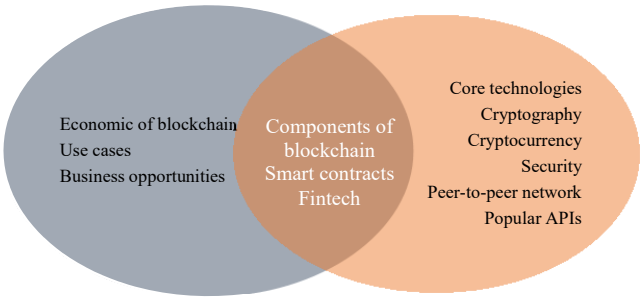

Fig. 1 Topics of blockchain

On the business side, Professor David Yermack of New York University's Stern School of Business, for example, has offered a digital-currency class since 2014. However, the instructional objectives seem to center on "fintech" which is a rising topic (and could be a new subject) to study how financial technologies are revolutionizing enterprises. The instructional content focuses more on helping students connect business strategy to technology to enhance competitive opportunities.

On the technology side, Stanford's "CS 251: Bitcoin and Cryptocurrencies" is a highly CS-centered course which focuses on all aspects of cryptocurrencies [13]. Topical areas include hash functions, mining, Merkle trees, smart contracts, tokens, mining algorithms and hardware, various types of cryptocurrency wallets, Bitcoin clients, merchants, and payment processors. The CS side of instructions lean more towards discussion of cryptography, encoding, digital signature, distributed ledger, immutable records, decentralized networks, data transparency, and audit trail. To most community college students, discussing blockchain technologies from the CS angle is relatively difficult and probably requires intensive subject matter to fully internalize and understand.

VI. Knowledge Prerequisites

For an introductory course to blockchain that discusses about the business aspects of applications to nontechnical audiences, students should have some business background including accounting, finance, marketing, and management to gain an understanding of how blockchains work and how they can create value for their business through cost-savings and efficiencies. For an introductory course that discusses the technical aspects of blockchain, students must have some CS-related background, particularly. Some background in basic computing technologies, such as programming, networking, and database management, is a plus, while knowledge in cryptography, distributed computing, and mechanism design are probably necessary.

VII. Textbook Readiness

A group of computer science professors at Princeton University published a textbook [7]. This book offers a solid illustration of what cryptocurrencies are with a detailed explanation about the collection of technologies that construct the blockchain and how and why value can be stored and transferred securely and publicly on distributed networks. Interestingly, this book is not designed for most non-technical students to comprehend the essential content from the ground up within a one-semester blockchain course. Table III is a sample list of books that could be used as supplementary textbooks.

Taking into consideration the profiles of community college students, all these books are good references, yet it might be difficult for an instructor to choose any of them as the sole textbook to cover the basics of blockchain on either the business or CS side.

VIII. Recommended Pedagogies

Unlike traditional universities, courses taught at community colleges are more career-oriented, less theoretical, and expectedly practical. For a course that covers technical topics, effective pedagogies are the ones that lean towards the following characteristics.

- Hands-on learning: Interactive learning activities and workshop-based pedagogy work better than traditional textbook and lecture pedagogy.

- Group learning: Students showed a better learning outcome through peer-based discussions and competency-based collaborations. All students are organized into small groups to contribute to the learning group based on their technical competencies. While the term competency refers to a set of capabilities of an individual to perform a specific task properly, a competence-based collaboration may force students to demonstrate their knowledge, skills, behavior, and professionalism.
- Project-based learning: Scenario-based projects could better engage students in hands-on learning activities that put what they learn into practice.
- Case study: Students can be actively engaged in figuring out the principles by abstracting from the examples and this could develop their skills in problem solving, analytical tools, decision making in complex situations. One example is the partnership between the US Food and Drug Administration and IBM's Watson Health.

These pedagogies inevitably set some instructional limitations because they require a time-consuming preparation of instructional materials and initial investments of equipment and software (such as APIs).

IX. Instructor Pool

Finding quality instructors to teach blockchain courses is a challenge, even for top-ranking universities [1]. Many startups do not have master or higher degrees to be qualified for teaching at college level, especially those devoted to the development of technologies; this phenomenon makes the shortage of instructors more severe at the CS side.

X. Evaluation Results

The author adopts a rating scale of 1 to 5, to indicate the degree of appropriateness to teach the topical area of blockchain at community college: 1 is easy, 2 is appropriate, 3 is manageable, 4 is difficult, and 5 is impossible. The term "manageable" means the instructor can adjust the pedagogies to resolve instructional issues, "difficult" means both instructors and students will struggle to meet the objectives, while "impossible" simply means "not doable" for community colleges. In Table IV, the author abbreviates the "seven aspects" with two letters like "TM", which is short for "Technology Maturity". Results of the evaluation show the author's perspectives about the practicability for teaching an introductory course blockchain at community colleges.

TABLE III
Sample Supplementary Textbooks

Author	Year	Title	Publisher
Andreas Antonopoulos	2017	Mastering Bitcoin: Programming the Open Blockchain	O'Reilly Media
Artemis Caro	2017	Blockchain: The Beginners Guide to Understanding the Technology behind Bitcoin & Cryptocurrency	CreateSpace Independent Publishing
Daniel Drescher	2017	Blockchain Basics: A Non-Technical Introduction in 25 Steps	Apress
Alan Norman	2017	Blockchain Technology Explained: The Ultimate Beginner's Guide about Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA and Smart Contract	CreateSpace Independent Publishing Platform
Abraham White	2018	Blockchain: Discover the Technology behind Smart Contracts, Wallets, Mining and Cryptocurrency	CreateSpace Independent Publishing

TABLE IV
Ratings

Topical Area	Subject Area	TM	IM	RA	SC	KP	TR	RP	IP	Total
Economic of blockchain	BS	2	1	2	1	2	3	2	2	15
Use cases	BS	2	1	2	1	2	3	2	3	16
Business opportunities	BS	1	1	2	1	2	2	3	2	14
Components	BS / CS	2	2	3	3	2	3	4	3	22
Fintech	BS / CS	2	1	2	3	2	2	2	3	17
Smart contracts	BS / CS	3	3	3	3	3	3	3	4	25
Peer-to-peer network	CS	2	3	3	1	3	3	3	3	23
Core technologies	CS	4	3	3	1	5	3	4	4	27
Cryptography	CS	3	4	4	1	4	3	4	4	27
Cryptocurrency	CS	3	4	4	3	4	3	4	4	29
Security	CS	5	4	3	1	5	3	4	4	29
Popular APIs	CS	3	4	3	1	4	5	4	4	28

It is necessary to note that "core technologies" include topics like record immutability, digital tokens, registry of transactions, hash functions, mining, Merkle trees, smart contracts, mining algorithms, and all other highly technical topics. Although blockchain can be used to secure transactions, the algorithm used to drive blockchains is not immune from hackers-related vulnerabilities. For example, in August 2016, a cryptocurrency exchange agency called "Bitfinex" was compromised and lost 120,000 bitcoins.

Results of evaluation, as shown in Table III, indicates that the business side of blockchain topics are more appropriate for the level of readiness of community college students. An ideal student is a person with foundational knowledge of business including basic management, accounting, and computing. Some background in finance and operation management will help but is not required.

The CS side of blockchain topics requires students to learn applied cryptographic principles (asymmetric vs. symmetric encryption, digital signatures, hashing, message authentication, generating and safely transferring key pairs) as well as knowledge in building and scaling decentralized and distributed systems. These CS-related topics are more appropriate for an upper-division course that guides CS majors.

XI. Conclusion

Like many emerging technologies, it is very early to assert how blockchain will impact business operations. Since a comprehensive course about the technical aspects of blockchain and its uses in cryptocurrencies requires students to have sophisticated foundations of upper-division CS- or math-related courses, it is more feasible to offer community college students with a business course that teaches them key vocabulary and basic concepts of blockchain and how they are impacting the world of business.

An ideal course to offer at a community college is an introductory course for students to understand what blockchain is and how it applies to business. This course may not engage students in sciences and technologies that drive blockchain, although the discussion of some technical topics is inevitable, the authors recommend not to offer community college students a course for learning how to program blockchain applications.

References

[1] Arnold, M. (2017). How business schools teach cryptocurrencies. Website of Financial Times. https://www.ft.com/content/2d161cf6-c3b1-11e7-b30e-a7c1c7c13aab.

[2] Ball, T. (2017). Top 10 biggest blockchain players. Computer Business Review. https://www.cbronline.com/uncategorised/top-10-biggest-blockchain-players/.

[3] Banker, S. (2018). The Growing Maturity of Blockchain For Supply Chain Management. Forbes. https://www.forbes.com/sites/stevebanker/2018/02/22/the-growing-maturity-of-blockchain-for-supply-chain-management/#6735445f11da.

[4] del Castillo, M. (2017). Bitcoin in the Browser: Google, Apple and More Adopting Crypto-Ready API. Website of Coindesk. https://www.coindesk.com/bitcoin-browser-google-apple-move-adopt-crypto-compatible-api/.

[5] Forbes Agency Council. "10 Ways Blockchain Could Change The Marketing Industry This Year". Forbes. Feb 28, 2018, https://www.forbes.com/sites/forbesagencycouncil/2018/02/27/10-ways-blockchain-could-change-the-marketing-industry-this-year/#2464a13f48ba.

[6] Miller, R. (2017). The promise of managing identity on the blockchain. Website of the Oath Tech Network. https://techcrunch.com/2017/09/10/the-promise-of-managing-identity-on-the-blockchain/.

[7] Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: A comprehensive introduction. Princeton University Press.

[8] Rosic, A. (2017). 17 Blockchain Applications That Are Transforming Society. Website of Blockgeeks, Inc. https://blockgeeks.com/guides/blockchain-applications/.

[9] Swinhoe, D. (2018). Blockchain technologies face a maturity problem. Website of IDG Connected Ltd. https://www.idgconnect.com/abstract/30525/blockchain-technologies-maturity.

[10] Tapscott, D, & Tapscott, A. (2016). Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World. Portfolio.

[11] Tapscott, D, & Tapscott, A. (2017). The Blockchain Revolution and Higher Education. EducauseReview, 17(3), p. 11-24.

[12] U.S. Department of Health & Human Services. (n.d.) The HIPAA Privacy Rule. https://www.hhs.gov/hipaa/for-professionals/privacy/index.html.

[13] Website of Applied Cryptography Group of Standord University. CS 251: Bitcoin and Cryptocurrencies. https://crypto.stanford.edu/cs251_fall16/.

[14] Wu, L. (2018). Blockchain Smart Contracts In Megacity Logistics. Master's Thesis. Penn State University.

[15] Zheng, Z., Xie, S, Dai, H., Chen, X, and Wang, H. (2017). An overview of blockchain technology: Architecture, consensus, and future trends. Proceedings of 2017 IEEE 6th International Congress on Big Data, p.557-564. DOI 10.1109/BigDataCongress.2017.85.