Empowering Accounting Education: The Application and Impact of Knowledge Graphs

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Abstract: On the basis of 12 years of teaching experience and research work, the author points out three major challenges existing in accounting education: excessive focus on theoretical knowledge that impedes the application of practical skills, inactive learning environments that restrict critical thinking, and inadequate integration of digital tools that makes students unready for contemporary accounting work. These defects not only reduce the effectiveness of learning but also widen a notable gap between academic training and industrial demands. During the past three years, the introduction of knowledge graphs into accounting courses has become a teaching innovation with observable educational advantages. Practical data obtained from the Principles of Accounting course shows a 30% improvement in students' academic performance after the application of this method. This technical approach enables dynamic mapping of the relationships between concepts, cultivating cognitive structures that are necessary for solving practical problems. At the same time, instructors can make use of intelligent teaching platforms like Chaoxing Learning Platform to build knowledge graphs, carry out interactive teaching methods, and strengthen group cooperation. Regular updates to knowledge graphs play an effective role in narrowing the gap between academic teaching and accounting practice. Although knowledge graphs have great prospects, there are still difficulties in content adaptation, interdisciplinary expertise, and operational maintenance. In spite of these limitations, knowledge graphs have considerable potential to transform accounting education by means of systematic curriculum improvement.

Keywords: Knowledge Graphs; Accounting Education; Technology Integration

1. Introduction

Emerging in the 1980s, knowledge graphs are distinguished by their structure, where nodes represent entities and edges denote their relationships. These tools transform complex data into easily interpretable frameworks. As large-scale data technologies have progressed over time, knowledge graphs have found practical applications in fields such as e-commerce, finance, and smart healthcare.

Consider the Bloomberg Terminal, a fundamental tool relied upon daily by financial professionals. It utilizes semantic mapping to clearly present corporate relational data, including details like a firm's suppliers, main clients, competitors, their geographical locations, and even risks such as supply chain disruptions caused by policy changes. This clarity is invaluable for investors when evaluating sectors, such as electric vehicle manufacturers, which rely heavily on rare earth materials concentrated in specific regions. Despite ongoing data privacy concerns, such as adhering to GDPR regulations, knowledge graphs play a crucial role in managing financial risks. Unstructured financial data is growing exponentially today, making effective organization a must. Knowledge graphs lead in meeting this need. Paired with deep learning (e.g., neural network-based entity recognition), they improve unstructured data processing, boosting financial decision-support system reliability.

Current accounting education faces an urgent need to align with industry transformation driven by digitalization[1]. However, the author's 12-year teaching experience reveals traditional pedagogy's overemphasis on memorizing accounting rules and procedures often fails to cultivate students' data-driven decision-making and systematic thinking capabilities. Some researches indicate adopting new technologies (particularly big data analytics) could help bridge this gap[2] . Over 70% of the 2024 graduating class from our school secured positions at corporations and accounting firms within the Guangdong-Hong Kong-Macao Greater Bay Area. The survey targeting them revealed that big data analytics skills and interdisciplinary learning capabilities were key competitive advantages in job applications. Employers now expect expertise that combines finance, data science and ethics[3] .This gap can be bridged by KGs. For instance, instructors can create a graph linking accounts receivable (node) to revenue recognition principles (node) via an "impacts" edge. Also instructors can connect depreciation methods to International Accounting Standard 16 – Property, Plant and Equipment (IAS 16 PPE) with "compliance" relationships. This KG-based teaching methods bridge textbook theories to real-world decision-making without requiring coding skills, making it adaptable to standard classrooms. Such visualization helps students systematically grasp complex interdependencies while aligning with case-based pedagogical practices common in business curricula. This study explores how knowledge graphs strengthen accounting education in our business courses for Accounting, Financial Management, and Auditing majors by equipping students with both technical precision and interdisciplinary insight.

2. Knowledge Graphs in Accounting

2.1 Core Components of Accounting Knowledge Graphs

A knowledge graph structures domain-specific information through interconnected semantic relationships. At its core, it consists of three fundamental elements: entities, relations, and attributes. In accounting, entities serve as foundational accounting components, such as assets, liabilities and owners' equity. Assets are economic resources that an enterprise controls, such as Apple Inc.'s property, plant, and equipment. Liabilities are the enterprise's obligations, like Apple's accounts payable. Owners' equity represents the residual interest after deducting liabilities. Relationships articulate interactions between these entities, most notably the fundamental accounting equation Assets = Liabilities + Owners' Equity, which governs resource financing. Operational activities further demonstrate relational dynamics. For instance, product sales reduce inventory (an asset) while simultaneously increasing revenue and cash flow. Attributes supplement these elements with contextual details. For example, inventory valuation methods critically impact profit margins. When inventory prices rise, the First-In, First-Out (FIFO) method results in higher cost of goods sold (COGS) compared to the Weighted Average method, thereby reducing reported profits. Similarly, debt maturity terms determine liquidity management strategies. If a company faces significant short-term debt repayments, its current ratio will decline, necessitating enhanced short-term debt repayment capacity. These components establish a structured framework for analyzing financial transactions, enabling systematic knowledge organization to support stakeholder decision-making.

2.2 Six-Phase Framework for Knowledge Graphs Creation

The creation of domain-specific knowledge graphs generally involves six interrelated stages as shown in Figure 1[4]. The process commences with requirement analysis, where researchers establish the system's purpose and user needs. For instance, when developing a knowledge graph for learning the International Financial Reporting Standards (IFRS), a key requirement for educators may involve clarifying the distinctions and connections between IAS (International Accounting Standards) and IFRS. Subsequent knowledge acquisition involves aggregating heterogeneous data sources, ranging from structured ERP system records and semi-structured XBRL filings to unstructured annual reports and contractual documents. The diversification of data sources becomes evident when examining corporate ESG disclosure practices. Taking Apple Inc. as a case study, over the past five years (2021-2025), Apple's ESG reporting has undergone substantial evolution in both format and content. The disclosure format transitioned from static PDFs (2021-2022) to interactive web platforms complemented by downloadable supplements (2023-2025), thereby improving accessibility. In terms of content, environmental disclosures advanced from broad carbon neutrality commitments to detailed metrics, such as product-level lifecycle assessments (e.g., an 80% carbon reduction in the Mac mini) and initiatives for supply chain decarbonization.

When moving on to the third stage of information extraction, either rule-based algorithms or machine learning models can recognize three key components of knowledge graphs (KGs): entities, relationships, and attributes. In the context of accounting learning, taking the accounts receivable chapter as a specific example, entities cover accounting elements like "accounts receivable," "customers," and "allowance for doubtful accounts." Relationships appear in the form of creditor-debtor associations—for instance, Client A being in debt to Company B—as well as accounting processing rules where provisions for accounts receivable have an impact on the allowance for doubtful accounts. Attributes record quantitative or qualitative information such as "unpaid amount," "days past due," and "credit level." By virtue of the structured combination of these components, it becomes possible to track receivables visually through client transaction records, trigger automated risk warnings based on the analysis of aging data, and generate all-inclusive financial reports that include bad debt ratio calculations across various aging periods.

In the fourth stage of knowledge fusion, inconsistencies in concepts are addressed. When focusing on the accounts receivable chapter, this stage includes standardizing terminologies (e.g., equating "notes receivable" with "commercial drafts"), harmonizing rules for bad debt provisions across different sources—such as setting a 5% rate for debts with a term of less than one year and a 10% rate for debts with a term of 1-2 years—and integrating credit risk indicators from Chinese Accounting Standards (CAS) and practical cases (e.g., connecting the theoretical concept of "client credit tiers" to the actual "payment history" fields in real scenarios). This all-round process, which involves terminology unification, rule coordination, and the integration of multi-source data, eventually creates a consistent and inference-enabled knowledge system for the management of accounts receivable.

Subsequently, the data modeling stage formalizes these elements into ontologies that align with accounting standards (e.g., IFRS classifications) while mapping hierarchical relationships between concepts. Finally, graph implementation deploys the structured knowledge into databases like Neo4j or RDF stores. This methodology transforms fragmented financial data into an interconnected knowledge base, enhancing both analytical precision and operational transparency.

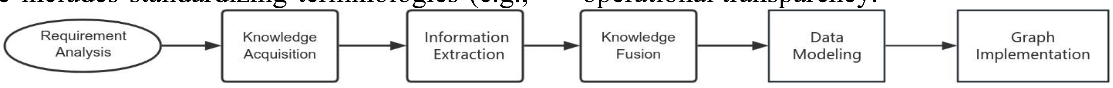

Figure 1. Six-Phase Framework for Knowledge Graphs Creation

3. Literature Review

Over the past five years, knowledge graph research in accounting education has demonstrated notable advancements across three dimensions: pedagogical innovation, curricular system design, and educational reform analysis. Some educators have integrated KGs into course-specific instructional frameworks. A prominent example is the Intermediate Financial Accounting course offered on the Xueyin Online platform, where AI-driven Knowledge Graph technology dissected the teaching material into numerous hierarchical knowledge nodes. These nodes, interconnected through semantic relationships, were visualized as knowledge graphs, mind maps, and outlines. This approach facilitates systematic reinforcement of domain knowledge and cultivates cross-course conceptual linkages[5]. Also KGs have proven instrumental in constructing unified accounting knowledge systems spanning core curricula. Through structural modularization of course content (auditing standards, tax regulations, etc.), educators gain flexibility in designing adaptive teaching strategies, while students achieve autonomous mastery of interdisciplinary connections. Third, bibliometric analyses using tools like CiteSpace reveal critical trends in accounting education reform. Keyword co-occurrence mapping reveals three primary clusters: (1) integration of curriculum ideology, (2) pedagogical innovation specific to disciplines, and (3) practical pathways for implementing ethical accounting training [6].

In terms of methodology, knowledge graph embedding (KGE) tackles domain fragmentation issues by converting entities and relationships into organized vector structures. Although traditional KGE models depend on (head, relation, tail) triples supplemented with external data sources, they often struggle to capture the hierarchical dependencies that are intrinsic to accounting frameworks—for example, the mapping relationships between audit risks and audit evidence[7] . The global association rule mining approach alleviates this drawback by systematically integrating fragmented domain knowledge; a typical application includes matching case precedents with continuously updated accounting standards[8] .

However, three critical gaps persist: (1) insufficient comparative analyses of KG implementation efficacy across heterogeneous educational contexts, (2) underdeveloped integration between KG architectures and emerging technologies (e.g., generative AI), and (3) limited translational research bridging academic findings to classroom applications. Future studies should examine how structured knowledge frameworks can be systematically applied across accounting curricula. Such investigations may enhance accounting education quality and and better prepare graduates for evolving industry requirements.

4. Problems of Traditional Accounting Teaching in Higher Education

4.1 Over-Emphasis on Theoretical Knowledge

The author's 12-year teaching experience reveals that in traditional accounting teaching in universities, there is a prevalent over - emphasis on theoretical knowledge. The curriculum is often designed to cover a vast amount of accounting principles, standards, and regulations. For example, students spend a significant amount of time memorizing complex accounting rules regarding revenue recognition, asset valuation, and liability measurement. The curricular imbalance toward theoretical instruction creates negative impacts. Although learners achieve fragmented rule comprehension, they often fail to develop operational proficiency in real - world scenarios. They might be proficient in answering theoretical exam questions but struggle when faced with practical accounting tasks, such as preparing financial statements for a real -life business with its unique set of transactions. In the 2021 curriculum reform of our college's professional development program, we piloted the integration of practical accounting courses alongside the theoretical Principles of Accounting course for first-year accounting majors, aiming to address the overemphasis on theoretical instruction.

4.2 Lecture-Centric Approach Constrains Interactive Learning

Traditional lecture-driven methods also hold back participatory learning in accounting education. In most classrooms, instructors mostly present accounting principles through standardized case analyses—with students passively taking in information and doing formulaic exercises. Take fixed asset teaching: when explaining the straight-line method formula (which calculates annual depreciation by dividing cost by useful life), instructors often use static PowerPoint slides. This way lacks interactive elements that let students dynamically see how changing useful lifespans or salvage value rates affect depreciation results. Assignments are usually limited to numerical tasks, like calculating annual depreciation for equipment costing 100,000 yuan initially, but they don't include discussions on the asset's full lifecycle—from acquisition and use to disposal.

What's more, accounting education today still has a shortage of collaborative problem-solving and inquiry-based learning practices. Modern tools like knowledge graphs also haven't been systematically integrated into teaching. Take depreciation methods teaching as an example: instructors rarely guide students to discuss in groups how different approaches affect financial statements. Common ones include the straight-line method and the double declining balance method, which is part of accelerated depreciation methods. Students also barely get any chances to conduct case analyses on asset lifecycle management, or use knowledge graphs to connect key elements. These elements include asset acquisition costs, depreciation schedules, and disposal procedures. This passive teaching prevents students from engaging in in-depth cognitive thinking. Instead of examining real-world business cases, such as asset impairment testing that enterprises need to conduct at the end of the year and tax optimization work involved in daily operations, learners are stuck memorizing accounting journal entries. As a result, students end up with fragmented knowledge, rather than developing the analytical skills required to evaluate fixed asset decisions in a dynamic business environment[9].

4.3 Simplified Cases Disregard Real-World Complexity

A significant gap persists between theoretical instruction and practical application as accounting practices evolve with advancements in big data and artificial intelligence, rendering traditional curricula inadequate to address multidimensional workplace challenges. A prime example lies in revenue recognition for e-commerce platforms, where textbook cases predominantly focus on "shipment confirmation" and "delivery confirmation" while real-world scenarios demand far greater complexity. Practical requirements include allocating deferred revenue for cross-platform promotions. A leading platform's 2024 financial report shows 43% of promotional vouchers were actually redeemed. Companies must also establish provisions for estimated liabilities related to 7-day no-questions-asked return policies given the industry's average return rate of 18.5%. This oversimplified training leaves over half of students unable to accurately calculate progress toward fulfilling performance obligations when confronted with specialized transactions outlined in the Ministry of Finance's Revenue Recognition Application Cases. To bridge this gap, reconstructing pedagogical case systems using sanitized real-world financial-operational datasets from enterprises is strongly recommended.

5. The Application of Knowledge Graphs in Accounting Education

5.1 The Value of Accounting Knowledge Graphs: From Relationship Visualization to Holistic Cognition

Since 2020, our department has implemented blended learning via Chaoxing platform in over 50% of core courses, achieving measurable improvements: increased classroom interactions and over 30% efficiency gains in assignment feedback. Key functionalities deployed include QR code-based attendance tracking, real-time online discussions, and digital assignment evaluation. Building on this foundation, faculty teams have introduced knowledge graphs since 2023 into selected courses including Principles of Accounting, Intermediate Financial Accounting, and Big Data Financial Analysis. These knowledge graphs effectively bridge theoretical knowledge with practical applications. This approach has already proven effective in STEM (Science, Technology, Engineering, and Mathematics) education, suggesting similar advantages could be achieved in accounting curricula. In the context of traditional accounting education's excessive focus on fragmented theoretical knowledge, knowledge graphs offer viable solutions for establishing interdisciplinary linkages within accounting education systems.

An accounting-specific knowledge graph lays out clearly the relationships between accounting principles, standards, and regulatory requirements. This full view lets students spot how things connect in accounting knowledge more deeply. Students no longer have to memorize isolated rules by rote. Instead, they can work out how concepts connect and gain a full sense—and this skill makes their decision-making better in actual accounting tasks.

As depicted in Figure 2, the knowledge graph for the extended accounting equation aids in visualizing the hierarchy and interconnections of accounting components through practical, stepwise operations. Educators initially present the graph's core structure on teaching tools, highlighting key nodes such as "Assets + Expenses", "Liability", and "Equity + Revenue", along with their relationships to the equation "Assets + Expenses = Liabilities + Equity + Revenues". They then guide students to drag and label each node, elucidating these nodes as fundamental to comprehending the equation's logic.

When focusing on the concept of "Liability," instructors illustrate how to expand it interactively: clicking on this node unveils "Current Liability" and "Non-current Liability." Students then populate these categories with typical accounting items. For instance, they add "accounts payable" under "Current Liability," linking it to a clothing store's 20-day credit purchase of 100 winter jackets. Similarly, they include "bonds payable" in "Non-current Liability," which pertains to a car factory's issuance of 7-year, ¥50 million bonds for financing new production lines. Students sketch lines between nodes (for example, from "accounts payable" to "Liability") to demonstrate cause-and-effect relationships, getting to know how each component affects the equation's balance. By repeating these tasks, like expanding nodes, connecting scenarios, and mapping relationships, students are able to understand component hierarchies and apply the equation in practical situations.

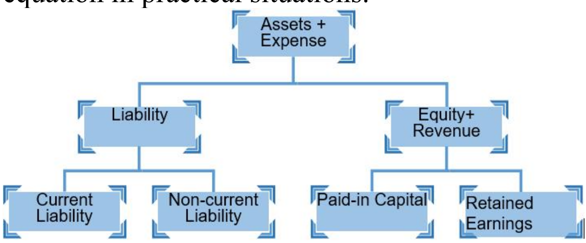

Figure 2. Extended Accounting Equation Knowledge Graph

5.2 Knowledge Graph-Based Teaching Reform in Accounting: Covering Pre-Class, In-Class and Post-Class Stages

Knowledge graphs also drive pedagogical innovation in accounting education. Educators leverage knowledge graph-based platforms to build dynamic learning systems, directly addressing the rigidity of traditional lecture-style curricula that often fail to connect theory to practice. When constructing knowledge graphs for accounting courses, a three-tier structure should be adopted: the foundational layer (which covers conceptual definitions and regulatory requirements), the relational layer (which includes formula deductions and business scenarios), and the application layer (which comprises case analyses and virtual simulations). In "fixed assets" teaching, pre-class interactive mind maps highlight key nodes: fixed asset recognition criteria (e.g., distinguishing fixed assets from current assets based on usage period) and common depreciation methods. During classes, instructors use the platform's screen annotation tool to demo formula derivations—for the double-declining balance method, they specifically clarify how book value decreases annually and why salvage value is ignored until the final year, fixing students' common misunderstandings. Post-class, big data analytics creates personalized practice plans: students who struggle with impairment calculations (identified via low quiz scores) receive targeted tasks, like analyzing tech firms' annual reports to compute impairment provisions for outdated equipment. This is the way blended learning operates, which brings multiple benefits to "fixed assets" teaching by integrating modern technological tools with interactive instructional methods. Blended learning effectively boosts student engagement by offering personalized learning pathways that foster independent study skills[10].

5.3 From Knowledge Graph Updates to Industry Collaboration: Connecting Accounting Theories with Professional Practice

To bridge the gap between traditional accounting education and real-world practice, updating knowledge graphs is crucial—this ensures they reflect the latest advancements in accounting, such as tax filing modifications and changes in ethical guidelines. In 2024, our institution partnered with Zhuhai-based Huisuangzhang, a leading provider of intelligent accounting solutions, to host a competition centered on large financial models. Students from Accounting, Financial Management, and Computer Science collaborated across disciplines. Accounting majors took the lead in analyzing financial statements, with a focus on verifying the accuracy of revenue recognition and identifying potential risks in cost allocation—key steps to ensure the reliability of financial data used in the competition's models. Meanwhile, computer science students refined data input processes for the models: they designed automated validation checks to reduce manual entry errors and adjusted data formatting to align with the models' algorithmic requirements, streamlining the overall data processing workflow. Knowledge graphs facilitated case analysis by connecting accounting standards to actual business scenarios. Huisuangzhang sponsored cash prizes for the top-performing teams. The competition demonstrated that industry collaboration is essential for high-quality accounting education. This approach equips students to apply theoretical knowledge in industry-relevant contexts, enhancing their career readiness and effectively narrowing the divide between theory and practice.

6. Challenges and Conclusions

6.1 Difficulties in Adapting Teaching Content to Knowledge Graphs

Knowledge graphs significantly enhance the value of accounting education by "structurally presenting relational connections." For instance, in introductory accounting courses, they assist students in visualizing how "asset recognition" is interconnected with "depreciation calculations" and "balance sheet classification," thereby transforming abstract conceptual relationships into clear, navigable nodes. However, accounting teaching content inherently possesses two characteristics—dynamic variability and complexity—which pose substantial challenges to adaptation.

One common case appears in Intermediate Financial Accounting, when instructors explain standards like IFRS 15. This standard follows a logical "five-step model," so knowledge graphs must convert key processes—"contract identification,""separation of performance obligations,""allocation of transaction prices"—into clear nodes and links. Revenue recognition methods also differ across industries: manufacturing companies use “point-in-time recognition,” while service businesses rely on “over-time recognition.” To capture these differences, knowledge graphs need many industry-specific labels—but too many labels can confuse students. In one classroom pilot, 60% of students using an IFRS 15 graph (with 6 industry sub-branches) said they felt “overwhelmed by node clutter,” which ended up lowering their learning efficiency.

6.2 Operational Complexities in Maintaining Education-Focused Accounting Knowledge Graphs

Beyond this, sustaining a knowledge graph introduces operational complexities that demand careful management. Developing an accounting knowledge graph with real educational value calls for interdisciplinary expertise spanning technical domains (e.g., graph database design) and accounting fundamentals (such as accrual accounting logic). Educators must systematically define functional connections between accounting concepts to ensure accuracy. Consider the accounting item "accounts receivable": instructors need to build precise associations between this item and core concepts like "revenue recognition"—a process that requires clarifying causal relationships, such as how revenue recognition criteria directly influence the balance of accounts receivable, and how specific credit terms (e.g., net-30 payment terms) determine the timing of revenue recording in financial statements.

6.3 The Educational Value of Knowledge Graphs in Accounting

Despite these challenges, knowledge graphs have clearly demonstrated their value in accounting education, offering tangible educational benefits. By visualizing abstract accounting concepts and organizing knowledge within a logical framework, they serve as a crucial bridge between theoretical frameworks and practical accounting applications—such as reconciling financial statements or applying tax regulations. The visual elements integrated into curricula aid learners in identifying interdisciplinary connections (e.g., how accounting data integrates with financial analysis) and tracking the evolution of core concepts (such as the transition from historical cost to fair value measurement). What’s more, interactive graph navigation tools let students explore accounting information networks by exploring nodes on their own. For example, when students click on the "inventory" node, they can access related nodes like "valuation methods" or "cost of goods sold"—this helps connect theoretical concepts to real-world scenarios, such as how retail stores adjust inventory levels during peak seasons like Black Friday or holiday sales. Collaborative case studies, such as analyzing a manufacturing firm’s financial reporting process, have further validated their effectiveness in enhancing knowledge retention. This kind of skill-building lines up directly with what the accounting industry now expects from professionals. Today’s employers—especially multinational corporations that operate across borders, dealing with different tax systems and reporting standards—need accountants who can navigate complex financial reporting platforms and make decisions based on data in fast-changing organizational settings.

Through nearly five years of education reform, we have achieved preliminary educational outcomes: Participation in disciplinary competitions and university innovation/entrepreneurship projects has yielded exponential growth, with the number of students winning national competitions and provincial-level innovation project approvals doubling. In professional certification, over 60% of students passed exams such as Junior Accountant, Banking Qualification, and Securities Qualification. Regarding employment, approximately 20% more accounting graduates secured positions in major firms like Lixin Certified Public Accountants, while postgraduate admission rates for Financial Engineering students rose by about 30%

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References

[1] Kilic, Burcu Isguden, Jim. The Effects of Big Data on Forensic Accounting Practices and Education. Contemporary Issues in Audit Management and Forensic Accounting, 2020, 102:11-26.
[2] Sufian, Nur Insyirah Mohamed, Kasim, Eley Suzana, Zin, Norlaila Md, Surtikanti, Surtikanti. Exploring the Diffusion of Big Data Analytics within Accounting Education. Asia-Pacific Management Accounting Journal, 2023, 18(3):199-229.
[3] Rezaee, Zabihollah, Wang, Jim. Relevance of big data to forensic accounting practice and education. Managerial Auditing Journal, 2019, 34(3):268-288.
[4] Peng, Ciyuan, Xia, Feng, Naseriparsa, Mehdi, Osborne, Francesco. Knowledge Graphs: Opportunities and Challenges. Artificial Intelligence Review, 2023, 56(11), 13071–13102.
[5] Liu Meijuan, Yu Bingbing, and Fang Cao. Research on the Construction of a Knowledge Graph-Based Intelligent Accounting Curriculum. Communications of Finance and Accounting, 2024, (13): 160-164+171.
[6] Wu Lijun. Two Decades of Educational Reform in Accounting Major: Research Hotspots and Trends—A CiteSpace-Based Knowledge Mapping Visualization Analysis. University Education, 2022, (02): 33-37.
[7] Niu, Jiaojiao, Chen, Degang, Ma, Yinglong, Li, Jinhai. The concept information of graph granule with application to knowledge graph embedding. International Journal of Machine Learning and Cybernetics, 2024, 15(12):5595-5606.
[8] Richong Zhang, Yongyi Mao, Weihua Zhao. Knowledge graphs completion via probabilistic reasoning. Information Sciences, 2020, 521:144-159.
[9] Berube, Janie, Gendron, Yves. Through students' eyes: case study of a critical pedagogy initiative in accounting education. Accounting Education, 2022, 31(4):394-430.
[10] Turk, Murat, Turk, Sinem Toraman, Muftuoglu, Ali Ceyhun, Karakaya, Ozlem, Karakaya, Kadir. Students' Expectations and Experiences about Engagement Strategies in Online Courses: A Mixed Methods Study. Online Learning, 2024, 28(2):239-267.

