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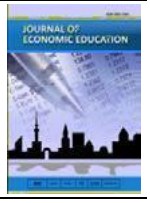

TEACHING THE ECONOMICS OF STANDARDS AT THE TERTIARY LEVEL: EVIDENCE FROM CHINA

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Abstract

The economics of standards (EOS) plays a critical role in improving product quality, stabilizing markets, and enhancing efficiency, yet its integration into tertiary-level economics education remains limited. This study aims to address this gap by proposing a comprehensive CMFS pedagogical framework—encompassing content, mode, faculty, and students—to guide the development of EOS teaching in higher education. Using a qualitative review of international policy documents, institutional practices, and China's emerging EOS education initiatives, the study analyzes how standards-related knowledge is currently positioned within tertiary economics curricula and identifies barriers to effective implementation. The findings show that EOS has not yet been systematically incorporated into university-level economics programs, largely due to insufficient research, limited course offerings, and inadequate faculty expertise. Global organizations have begun introducing EOS elements into economics education plans, and China has taken early steps to embed standards into tertiary-level teaching and research. The proposed CMFS framework provides practical approaches for strengthening EOS pedagogy, including integrating EOS modules into existing economics courses, diversifying teaching methods, and building faculty capacity. The study concludes that coordinated efforts among governments, educational institutions, industry stakeholders, standards bodies, and international organizations are essential to advance EOS education. Strengthening multidisciplinary and cross-border collaboration will support deeper theoretical development and enhance the long-term contribution of EOS teaching to the evolution of economics education.

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INTRODUCTION

The International Standardization Organization (ISO) defines a standard as a document that provides rules or guidelines to achieve best possible results (ISO 2025). Standards have authority and current optimality, characterized by consensus, knowledge refinement, optimization of order, and application of new achievements (Yang 2024a). The upcoming World Development Report 2025 focuses on standards for development, and its concept note defines standards as codified solutions designed for common and repeated use that are recognized by multiple stakeholders.

Standards have wide-ranging impacts, which include forming the foundation of traditional industries such as agriculture and safeguarding advances in emerging digital trade and the metaverse (Yang 2024a, 2024b). Standards enhance economic efficiency by promoting economies of scale. They produce network effects by improving interface compatibility and system interoperability. As more users adopt the same standard, the value of the product or service rises, generating positive feedback (Yang 2023b). Quality, safety, and environmental standards reduce information asymmetry and mitigate market failure. Standards stimulate international trade by increasing market access through unified requirements and conformity assessment practices (Yang 2023b; Yang and Du 2023). They lower transaction costs by conveying product attributes and promoting the development of global supply chains (ISO 2023a). However, standards also present some limitations. Their static nature may lag technological advancements and result in outdated rules (ISO 2023a). Compliance and certification costs burden small and emerging firms, thereby limiting competition and innovation. Moreover, conflicts among national or regional standards fragment markets, increase costs, and hinder technological progress (Yang 2024a).

The economics of standards (EOS) focuses on the economic implications of standards (Blind 2004; Swann 2010; Yang 2023a, 2023b, 2024a, 2024b, 2025; Yang and Du 2023). EOS teaching, while acknowledged as important, is not yet included in tertiary-level economics education (ISO 2023a). Therefore, this study constructed a CMFS framework —featuring content (C), mode (M), faculty (F), and students (S)—to conceptualize tertiary-level EOS pedagogy and enhance the positive contribution of tertiary-level educational institutions in EOS teaching.

This paper combines a literature review with the current situation analysis on standards teaching and research in economics. Our tertiary-level pedagogical CMFS framework makes a twofold contribution to the literature: (1) It integrates content, mode, faculty, and students to extend the pedagogical discourse beyond traditional economic teaching and addresses the complexities of standards in tertiary-level education. (2) EOS teaching based on the CMFS framework, enriches the discipline of economics and helps students, policymakers, and practitioners enhance practical standardization abilities

Development of the economics of standards

Since 2000, EOS research has expanded. Swann (2000) investigated 500 studies on the economic value of standards and the role of government in amplifying their impact. Blind (2004) emphasized the role of standards in technological progress and macroeconomy. Swann (2010) updated the review with over 200 studies and indicated that the economic impact of standards remains a black box with varied transmission channels. A 2024 literature review shows a growing body of EOS studies since 2000, accelerating after 2010, focusing on EOS theory on the classification, supply–demand, and economic effects of standards (Yang 2024a). Researchers have advanced the EOS framework by enriching content, adding perspective, and improving methodologies.

Necessity of teaching standards in tertiary-level economics education

Integrating EOS knowledge into tertiary-level education responds to the demand for standards expertise, enabling students to grasp the economic functions of standards, recognize implementation challenges, and apply standards in practice. Standards education, including international reporting (Hervieux, McKee, and Driscoll 2017), sustainability (Herzner and Stucken 2020), risk management (Barbosa, Carrasco, and Abarca 2022), and quality education (Vander Weerdt 2023), has gained attention in global economic discourse (Yang 2024a).

Standardization and economic organizations aspire to advance the teaching of standards in tertiary-level economics education. Professionals must assess the impact of new and revised enterprise standards based on their firms' internal rules (Asia-Pacific Economic Cooperation (APEC) 2019). The WTO (2020) emphasizes that standards education enhances trade policy transparency and supports international harmonization. As demand for professionals with standards expertise increases, teaching the economic benefits of international standards at the tertiary level is expected to help students shape the future of standards practice (ISO 2022). Organizations and stakeholders are working to ensure that standards are inclusive and address distinct needs and perspectives (Perez 2024). The American National Standards Institute (ANSI) recommends integrating standards into economics education at colleges, universities, and trade schools (ANSI 2025a).

The 2008 financial crisis has highlighted the shortcomings of mainstream economics, with movements such as the Occupy Wall Street challenging neoclassical thought (Earle, Moral, Ward-Perkins 2017). Although standards enhance compatibility and interoperability among economic entities, university curricula seldom include standards analysis or encourage students to create standards-based solutions (Katusic et al. 2017). Bernat (2020) advocated integrating standards into economics education to cultivate capable professions. Heikkilä, Ali-Vehmas, and Rissanen (2021) conducted a bibliometric review on the link between standardization and economic growth, emphasizing the value of embedding standards teaching in economics curricula. Despite

calls for education reform, mainstream economics remains dominant, while students call for change in their discipline's curriculum and pedagogy (Nelson 2018; Decker 2019; Delgado 2022).

Standards education in China

Education and training are part of the supply side of China's standardization policy system, providing platforms for talent development. Evolving through stages of follow-up, catch-up, and upgrading, this system devotes 18.56–20% of its efforts to building standardization capacity (Yang, Gao, and Zhou 2022). China's ambition to lead in international standardization (Gao, Gao, and Liu 2021; Driessen and Zhu 2024) has influenced its approach to standards education. Recognizing its strategic role in fostering innovation, economic growth, and global competitiveness, China has integrated standards education into national economic policy to strengthen the theoretical foundation of students and enhance the capacity to address standards-related economic challenges (Yang 2024b).

METHODS

This study adopts a qualitative document-analysis approach drawing on two types of sources. First, a structured review of peer-reviewed literature on the economics of standards and standards education identifies theoretical developments, teaching practices, and gaps in EOS pedagogy. Second, policy documents, guidelines, and program reports issued from international and regional standardization bodies (APEC, ISO, ANSI, DIN, AFNOR, and the Standards Council of Canada), together with Chinese national policies and funding announcements (NSSF projects, SAC/SWG27 and CAS initiatives), are examined to trace the incorporation of standards education into tertiary-level economics curricula. The comparison of these sources provided the empirical basis for describing the current state of standards teaching and research, identifying specific gaps in China, and constructing the CMFS framework, EOS module design, and the illustrative teaching schedule for tertiary-level economics education.

RESULT AND DISCUSSION

Current state of standards teaching and research in economics

Regional or international economic cooperation organizations.

In 2006, APEC launched the Strategic Education Program on Standards and Conformance, involving China, India, Japan, Korea, Peru, Singapore, Thailand, the United States, and Vietnam. The program progressed in three stages: (1) preliminary research, case studies, and curriculum design (2007–2008); (2) development of textbooks and teaching manuals (2009–2010); and (3) pilot implementation and evaluation (2011–2012). It established foundations for integrating standards education into national curricula and

promoted international cooperation. Since 2013, APEC has advanced programs linking standards education with innovation, trade, business strategy, and governances. Standards-related content has been integrated into curricula under APEC's Education Guideline on Standards and Conformance (APEC 2015, 2019). These efforts provide educational basis and best practices while encouraging participation in standards awareness and capacity-building to support businesses (APEC 2024).

Standardization organizations and tertiary-level educational institutions

International Electrotechnical Commission (IEC), International Telecommunications Union (ITU), International Cooperation for Education about Standardization, World Standards Cooperation, and the ISO offer standards education programs globally. The ISO 2011–2015 Strategic Plan and the ISO Strategy 2030 (ISO 2023a) reaffirm the strategic position of standards education.

To integrate standards curricula into European education, the European Committee for Standardization, the European Committee for Electrotechnical Standardization, and the European Telecommunications Standards Institute together established the European Joint Working Group on Standardization Education. The practices of industrial and emerging countries demonstrate their commitment to enhance standards teaching to contribute to economic development, innovation, and international cooperation (DIN 2023; ISO 2023a).

Regional and national standardization organizations emphasize integrating standards teaching into higher education. In Europe, universities such as Vaasa and Tampere collaborate with national standard bodies to implement formal standards education programs in engineering and business curricula (SFS 2023). Association Française de Normalization promotes standards teaching at the tertiary level and on-the-job education for students and employees through short-term college training programs and professional courses to confer degrees (ISO 2023b). Germany's standardization organization established professional standardization courses in universities, where graduates can obtain qualification certificates in standardization (DIN 2025). The United States urges tertiary-level educational institutions to include standards teaching programs in economics curricula. ANSI offers training courses to educate individuals about standardization systems and emphasizes the benefits of participation (ANSI 2025b). The Standards Council of Canada provides university students with standards knowledge and collaborates with the academic community to foster awareness on standards and incorporate their teaching in curricula (Standards Council of Canada 2025).

In Asia, the Korean Standards Association established five-year National Standards Master Plans (in 2001 and 2006) to modernize Korea's standardization system. It operates the University Education Program on Standardization, providing universities with unified curricula, teaching materials, and field-based learning to prepare future standards professionals. The Ministry of Economy, Trade, and Industry (2022) of Japan, in cooperation with the Japanese Standards Association and the Japanese Industrial Standards Committee, help universities establish professional courses on standards. Emerging

economies have updated national standards based on their positive economic outcomes and importance for enterprises. The China Association for Standardization (CAS) implements standards training programs for enterprises and the Standardization Talent Training Special Action Plan (2023–2025) to cultivate professionals with specialized competence (CAS 2023).

Incorporating standards in tertiary-level economics education and research in China

Education dimension

Although EOS is not yet defined clearly in the curricula, several universities in China have incorporated standards teaching into their education plans. China Jiliang University, Zhongnan University of Economics and Law, and Huazhong University of Science and Technology offer standards-related and quality management courses, encouraging students to pursue careers in economic disciplines with standards competency. In Chinese colleges and universities, standards appear as technical trade policy instruments in courses on international trade barriers and customs management. This exclusion from other major economics courses, such as innovation economics and economic growth theory in which standards are featured as indicators of technology or innovation capacity, obscures the scope of EOS in economic disciplines and stunts its theoretical development.

In 2024, the Plenary meeting of the Standardization Administration of China and the Standardization Working Group (SAC/SWG27) was held to (1) address "strengthening the construction of standardization talent teams" in the National Standardization Development Outline; (2) deploy the Standardization Talent Training Special Action Plan (2023–2025) to promote the integrated education of professions and standardization; and (3) cultivate and train standardization talents (China Standardization 2024). The SAC/SWG27's efforts show China's achievements in meeting the demand for qualified standardization professionals and aligning academic curricula with industry needs.

Research dimension

Tertiary-level educational institutions have made progress in securing funding (primarily from governments) for standards and economics study. From 2016 to 2021, only 0.36% (98 out of 27,132) of the projects approved by China's National Social Science Fund (NSSF), included the terms "standards" or "standardization." Ten approved projects undertaken by eight colleges and universities emphasized "Chinese standards" and "standardizations strategies" to investigate standards issues from economic perspectives (National Office for Philosophy and Social Sciences of China 2022).

The government has been increasing its financial support for universities to undertake projects on standards and economics. In 2021, it funded "Research on

Academic Frontier Theory and Policy of the Economics of Standards," the only project since 2000 with "the economics of standards" in the title, indicating a step forward toward increased funding for EOS. In 2024, NSSF funded projects such as "Research on the Impact of Standards Openness on the Upgrading of China's Value Chain" (National Office for Philosophy and Social Sciences of China 2024). These reflect the government's commitment to integrating standards into the economy, as well as the increasing recognition of EOS as a critical area for academic research and national policy development.

Gaps in current EOS teaching in China

First, mismatch between student demand and course availability. Although student interest in EOS has grown, most universities offer only a single course, often shared by full- and part-time students. Traditional lecture-based instruction, still common, undermines interactive learning and fails to develop mutual engagement between instructors and students (Alaagib, Musa, and Saeed 2019). This approach is inadequate for managers, developers, and users of standards. A more balanced pedagogical strategy, integrating lectures, hands-on training, and applied assignments, is necessary.

Second, the disconnection between the training of standards organizations and university curricula. While international organizations provide general training for industry personnel, such programs lack theoretical depth and do not encourage research. Universities, as centers of theoretical and empirical inquiry, are critical to advancing EOS teaching. However, few institutions offer specialized EOS courses. Of more than 3,000 Chinese universities, only a handful participated in APEC's standards education initiative. Even among institutions funded by the NSSF for standards-related topics, engagement in EOS education remains limited.

Third, fragmentation between economics and engineering education remains a concern. Despite state support, standards teaching in Chinese universities are confined to engineering and technical departments. These programs prioritize technical specifications but neglect economic implications, limiting students' capacity to explain the strategic value of standards or manage standardization initiatives within economic contexts. Bridging this disciplinary divide requires developing economics-focused standards curricula to prepare students for cross-functional professional roles.

Framework for teaching EOS in tertiary-level economics education

Intellectual foundation

Studies on standards implementation, policies, and teaching practices in secondary education serve as references to design a tertiary-level EOS teaching framework. Given the minimal evidence that best practices are used, students need more instruction about standards (Darzentas 2016). Kim (2017) suggested promoting standards teaching into a free-learning semester in Korean middle schools (e.g., career search, clubs, arts, and sports), based on theme-centered programs with selected standards topics.

Comprehensive training in standards teaching is necessary for both teachers and students. Although secondary school technology teachers recognize its value, they still need to develop more competence through experience and training in standards-related teaching methods (Kwon 2017; Lee 2018).

Clarifying the distinction between tertiary and secondary education is essential for EOS curriculum development. While tertiary education emphasizes theoretical depth and specialization, secondary education focuses on foundational knowledge and principles. This distinction highlights the need to define the content, mode, and subjects (teachers and students) for tertiary-level EOS teaching. ISO has classified educational initiatives on standards and standardization into categories for primary, secondary, and higher education (ISO 2025).

CMFS framework

Learning objectives, the content of an academic curriculum, and available materials for academic teaching are the main topics in standards education. Defining a structured and specialized approach to teaching EOS in tertiary-level education helps develop theoretical interpretation of EOS and its practical applications. Tertiary-level EOS teaching enhances students' comprehension of the economic effects of different standards, facilitates EOS research, and highlights the need for a CMFS framework (Table 1).

Content definition is critical because tertiary-level education investigates advanced and specialized topics. Economic principles are integrated with the characteristics of standards. EOS involves theoretical models, policy implications, and technical standards, all of which must be explicitly linked to core economic principles. Curriculum integration requires coverage of key themes, such as impacts on economic growth, international trade, and innovation. Without such clarity, instructors and students will struggle to situate EOS within the broader context of economic analysis.

Effective teaching methods hinges on desired learning outcomes (Mijatovic 2020), including in EOS teaching. Unclear EOS teaching modes weaken professional theoretical training and students' acquisition of practical capabilities. At the tertiary level, where analytical and research capacities are prioritized, EOS teaching requires methods such as case analysis, simulations, and project-based learning to bridge theory and application. This differs from secondary education's lecture-based focus on knowledge acquisition. Teaching modes cater to formal academic learners and users of applied learning platforms.

Professors need economic academic expertise and familiarity with standardization practices to teach EOS. The few available standards courses bring challenges in providing professors with the required knowledge, skills, and training. Universities should develop targeted professional development programs and workshops in collaboration with standardization organizations and industry experts. The teaching faculty should include a mix of academic teachers, hands-on trainers, and industry experts. Including corporate mentors in the faculty enhances the curriculum's relevance to modern business practices.

Interdisciplinary research and joint projects build faculty capacity by bringing economic theory and standardization practice.

Tertiary-level educational institutions with economics departments are committed to meeting the growing demand for competent and trained economists and business leaders. Students require a solid foundation in economic theories when mastering EOS. Thus, courses should encompass business strategy, innovation management, and entrepreneurial skills to supplement economic knowledge. Diverse student demographics, including enterprise managers, government officials, and standardization policymakers, broaden the program appeal and utility for professionals in implementing and managing standards. A focus on flexible credentialing, especially micro-credentials, highlights the course's adaptability to the contemporary education needs of traditional students and working professionals.

Table 1. Framework for EOS teaching at the tertiary education level

Content	**Mode**
Economics (40%), standards (30%), languages (30%)	Graduate (PhD, master's degree) (10%), bachelor's degree (20%), vocational education (40%), on-the-job training (30%)
• Basis of standards/standardization • Applications of standards • Formulation and implementation of standards • International standardization and practice	• World Standards Day • Standards-related cultural week • Short-term courses • Mid-term courses • Long-term courses
Faculty	Students
Professional teachers (50%), trainers (25%), corporate mentors (25%)	Obtaining a credit (30%), obtaining a micro-credential or micro-degree in EOS (40%), obtaining an EOS training certificate (30%)
• Professional center • Professors of economics • Professors of standards • Standardization professionals • Guest lecturers	• Undergraduate students • Graduate students • Enterprise managers and employees • Government officials • Standardization policymakers

Note: A micro-credential or micro-degree refers to a specialized online or offline certification program that provides in-depth learning and practical experience in a specific field. These programs are usually shorter in duration and offer more flexible study arrangements than standard degree programs.

Content

Tertiary-level educational institutions should flexibly integrate the concept and theory of EOS into economics education by developing an EOS module. Adding content requires diverting resources from other areas, which can lead to conflicts; groups with

vested interests (i.e., professors, administrative leaders, and other academic leaders) may object to their teaching faculties engaging in EOS. Therefore, incorporating EOS content into economics education would be more helpful than replacing existing economics courses with EOS classes or introducing EOS as a major or concentration in graduate education. EOS can be included in courses for students majoring in economics (Katusic et al. 2017) or international trade (Yang 2024a, 2024b). Research on industrial projects that focus on applying new standardized technologies could also be incorporated into EOS teaching.

Economics education includes specialized courses such as mathematics for economists (e.g., economic or financial mathematics), as well as economics of energy (Hafner and Luciani 2022) and economics of language (Ginsburgh and Weber 2020; Jayawickrama and Nawarathna 2024). These courses are designed for students to deepen their understanding of specific fields. Colleges and universities can learn from these when designing EOS modules. Table 2 provides examples of EOS modules that incorporate theory and methodology. Integration includes EOS modules that cover basic concepts, theories, methods, and practice.

Table 2. EOS Modules

Modules	**Concepts**	**Theories**	**Methods**	**Practice**
Content (topics covered)	Standards, standardization, national standards, international standards, harmonization of standards	New economic growth theory, national competitive advantage theory, heterogeneous firm trade theory, innovation economics, institutional economics, network economics, public goods theory	Empirical analysis, normative analysis, comparative case studies, computable general equilibrium (CGE) models, field experiments & surveys	Standards setting, modification standards, evaluation of standards, implementation effects
Courses	Standards and economics	Standards and economic growth/international trade/innovation	Analysis of frontier issues of EOS, regulatory impact assessment (RIA) training	Development and implementation of standards, simulation-based standard development projects, collaboration with national & international organizations
Specific	ISO reports,	Academic articles	Empirical studies	Academic

Modules	Concepts	Theories	Methods	Practice
readings	World Development report, World Bank, OECD reports	collected by EOS professors	from leading journals, industry case studies	articles collected by EOS professors; reports from international, regional, or national economic reports; and industrial enterprise reports

Students majoring in international trade or commerce, for example, can take courses such as Standards and International Trade with the module. Table 3 presents a typical EOS teaching schedule. Different types of courses—both compulsory and elective—should align with learning objectives. Colleges and universities could offer EOS teaching content on the positive roles and adverse effects of standards in economic activities. EOS courses need to help strengthen basic research on the economic effects of standards and provide policy suggestions for standards practices based on theoretical and empirical evidence.

EOS teaching should begin with general EOS courses for all economics students and later expand to include courses for specific majors (e.g., international trade, finance, and management). The limited availability of EOS textbooks requires educators to create teaching materials, such as specific reference material (e.g., an APEC case book), which can be challenging because of their lack of experience and resources (Heikkilä, Ali-Vehmas, and Rissanen 2021). Textbooks for EOS should engage and incorporate multimedia tools and focus on integrating real-life case studies on standards implementation, economic impacts, and industry practices. They need to provide practical examples of standards influencing trade, finance, and management to help students understand the applications of EOS theory. Tertiary-level educational institutions could use publications from standards organizations (e.g., ISO/IEC directives) for additional references.

Table 3. EOS teaching schedule (two credits, 32 class hours)

No.	Teaching chapters and content	Class hours	Faculty/teachers
1	Introduction to EOS and Its Economic Significance	2	Professors from the schools of economics and industry experts
2	Review of EOS research	4	Professors from the schools of economics

No.	Teaching chapters and content	Class hours	Faculty/teachers
3	Basis of standards	2	Professors from the schools of economics
4	Economic and Industrial Impacts of Standards	4	Professors from the schools of economics and enterprise professionals
5	Application of Standards	2	Enterprise professionals
6	Setting and Implementation of Standards	4	Enterprise professionals
7	Rules and Practices of International Standards	6	Professors from the schools of economics
8	Quantitative and Empirical Analysis of Standards	4	Professors from the schools of economics and technical experts
9	Case Studies of Global Standardization Strategies	4	Enterprise professionals and representatives from standards organizations (e.g., ISO, WTO, national bodies)
10	Practice in Organizations (Enterprises, Standard-Setting Organizations, and Regulatory Bodies)	6	Professors from the schools of economics and enterprise professionals
11	Examination (Standard-Setting and Harmonization)	2	Enterprise professionals
Total		**32**	

Note: The "two credits" refer to the academic credit system used at the institution, which corresponds to the amount of work expected from students in a course. Each credit represents 16 class hours, with a total of 32 class hours being equivalent to two credits.

Mode

The CMFS framework facilitates professional, academic, and vocational education on standards in colleges and universities as short-, medium-, and long-term courses. Tertiary-level educational institutions can cater to different learning preferences and needs by offering online (remote participation), offline, self-directed, and face-to-face learning opportunities.

Colleges and universities should clarify whether the teaching objective is to increase students' awareness of the importance of standards in economic activities or provide in-depth EOS knowledge. That distinction determines the teaching program's length. Institutions could design short introductory modules to raise awareness, with a focus on key concepts and examples. More comprehensive courses can be developed to support in-depth EOS knowledge, including case studies, empirical analysis, and practical applications. The curriculum length could be tailored accordingly, with shorter programs

emphasizing practical relevance and longer ones offering detailed theoretical and applied content.

Noncredit courses and classroom teaching are necessary as well. Short-term courses could include lectures given by EOS professors, delivered on World Standards Day (October 14), or during a cultural week devoted to standards. Medium-term courses could include a compulsory or elective lecture series for half or entire semesters. Long-term courses providing in-depth education on theoretical models and methods would encourage students to undertake research projects. After completing EOS courses, students should receive qualifications, training certificates, or credits.

Colleges and universities could offer academic competitions for professors and students in EOS. By forming project groups to establish national or enterprise standards in economics, students could be encouraged to understand the role of standards in economic development. Economics departments could conduct mock negotiations to set international and national standards. Students should be able to engage with different viewpoints, debate policy, vote on essential standards issues, and learn about the operations of standardization organizations. Curricula should incorporate critical thinking exercises, role-playing activities, and interactive discussions that simulate policy debates. Partnerships with standardization organizations could provide students with opportunities for practical exposure, such as internships or project-based learning, to deepen their understanding of the operations and impact of standards. Students could act as standards-setters, debating, negotiating, lobbying, and voting to replicate and learn from the process of setting standards.

Faculty

Employing professors to teach EOS poses a challenge. Korea follows a top-down approach to EOS teaching in accordance with its national culture and policy. Conversely, standards education initiatives in the United States and Europe follow a bottom-up approach and are driven by individual professors. The U.S. government invests in educating and training stakeholders (i.e., academia, industry, and small and midsize companies) to contribute to technical standards development. China's Jiliang University specializes in standards teaching and research, and it welcomes professionals with doctoral qualifications and experience in quality or metrological management, including faculty professors and lecturers in engineering and management (APEC 2015, 2019). Few faculty members, however, come from the field of economics; their absence impedes EOS education and future professional practice because it limits the integration of economic theory into practical standards knowledge. While turf battles between different fields may contribute to this scarcity, the real concern is the lack of interdisciplinary collaboration, which hinders the application of economic principles to the standards. Without the involvement of economics faculty, students may not be aware of the critical analysis of the effect of standards on economic performance, policy, and global trade.

Standards professors should therefore collaborate with economics departments to

integrate standards content into economics curricula. Concurrently, economics professors should undertake targeted training to expand their understanding of standards, enabling them to teach EOS courses effectively. To implement this collaboration, universities could offer joint workshops or professional development programs to equip faculty with the necessary knowledge and teaching strategies. Both standards and economics professors should establish interdisciplinary research teams, funded by academic institutions or industry partners, to conduct research that bridges the gap between economic theory and standards practice.

This challenge is linked to the training of EOS professors. Given the current lack of resources, including the limited availability of textbooks, training remains the predominant obstacle. A solution could be to select a group of experienced professors to take on the responsibility for self-training—for example, a one-hour self-guided class before beginning an EOS course—thereby leveraging their expertise to build a network of skilled instructors.

As training improves, the increasing number of faculty would require support. Professors should be able to teach classes and invite guest lecturers to ensure sustainable courses. Tertiary-level educational institutions should receive outside funding for EOS education and research. Professors with EOS qualifications from different universities could jointly apply for regional, national, or international research funds. National standards organizations should collaborate to establish a professional EOS center to integrate faculty resources across colleges and universities and assign professors to spearhead such initiatives.

To inspire and retain these professors, tertiary educational institutions need to recognize and encourage them, such as by building fair competition platforms for EOS professors and researchers in their professional title promotion, holding ISO conferences for EOS professionals, and selecting participants based on their academic or teaching contributions (e.g., published articles, innovative ideas), rather than based on recommendations from the tertiary-level institutions (e.g., government speakers, institutional leaders).

The need for EOS professionals in enterprises and public standards organizations is increasing. As industries expand and technological advances continue, the integration of standards into business operations becomes essential for maintaining competitiveness and compliance with international regulations. Public standardization organizations require professionals who understand the technical aspects of standards and possess the economic knowledge to assess their impact on market efficiency, consumer welfare, and economic development. Universities play a pivotal role in preparing future EOS professionals by offering specialized education that bridges the gap between economic theory, policymaking, and the practical implementation of standards.

Students

Research in non-standards pedagogy has shown that diverse student demographics

contribute positively to the learning experience by fostering peer learning, enhancing critical thinking, and providing insights into the subject matter (Abacioglu, Epskamp, and Fisher 2023; Trolian and Parker 2022). Integrating an EOS module into economics education equips students with the expertise needed to address the challenges of global standardization processes. The module must be customized for different types of students. They come from varied backgrounds, bringing diverse perspectives, enriching classroom discussions and fostering a holistic understanding of EOS scenarios. This multifaceted approach ensures that graduates are well-prepared to address both the challenges and opportunities arising from the development and implementation of standards.

Economics students working in enterprises (e.g., managers and standardization engineers) are stakeholders who need instruction on standardization. Colleges and universities can meet their learning needs by adjusting teaching content and modes to provide valuable courses. Classes for enterprise managers from different industries can be tailored to their specific conditions: courses designed for students from manufacturing enterprises could focus on product standards, compatibility standards, and economic growth; for students from service industries could emphasize service standards; and for agriculture students could focus on maximum residue limits standards and hazard analysis critical control point standards. Tertiary-level educational institutions should admit all interested students instead of only full-time undergraduate or postgraduate students. Allowing students of different ages and backgrounds to engage with EOS can promote a broader range of perspectives and practical experiences, enriching the learning process

CONCLUSION

This study concludes that EOS teaching remains largely absent from tertiary-level economics education, and the limited body of research has constrained the development of effective pedagogy. Although several global organizations have begun incorporating standards into their economics education initiatives, and China has taken early steps to integrate standards into university-level teaching and research, substantial gaps persist in course availability, teaching methods, and faculty expertise. The proposed CMFS framework offers a structured approach to addressing these gaps by guiding the gradual integration of EOS content and encouraging more diverse instructional modes. However, the advancement of EOS education will require stronger collaboration among governments, higher education institutions, industry stakeholders, standards bodies, and international organizations. Future research should expand empirical investigations into effective EOS instructional practices, evaluate student learning outcomes across different curricular models, and explore cross-national differences in EOS adoption. Continued contributions from scholars and practitioners are essential to deepen the theoretical foundations of EOS education and solidify its role in shaping the future of economics curricula.

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