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Contributions in: Concept Mapping, Inclusive Teaching, STEM, Inquiry-Based Learning, Professional Practice, Engineering Graduates, Teaching Methods, Automata Theory, Active Learning, First-year Engineering, Academic Integrity, Gamification, Material Science, Task Complexity, Graduate Students, Heat Exchanger, Teamwork, Cultural Orientations, Software, University Industry Cooperation, International Coteaching, Accreditation, Joint European Degrees, Major Selection, Retention, Flipped Classroom, Social Capital, Education Policy, Soft Skills, International Education, Problem Solving

The Role of the Concept Map in the Implementation of the STEM for the Development of the Creative Thinking Skills of Middle School Students in the 5.0 Era: A Systematic Review   1126–1135
Syafnan, Laila Surayya and Fitriani Surayya Lubis

Particularly in the context of Education 5.0, concept maps are an effective tool for assisting with the implementation of STEM education and developing high school students' capacity for creative thought. The goal of this study is to find and highlight a few publications that look at how concept maps can help implement STEM to improve creative thinking skills, especially for high school students in Education 5.0. We used a literature review as the research method, selecting scientific articles based on the PRISMA diagram. The inclusion step identified 23 papers as potential candidates for the literature review stage. We selected papers for publication based on their titles and abstracts. The result of this study shows that concept maps are particularly effective in the context of Education 5.0, whereas a pedagogical tool in STEM education helps develop students' creative thinking capabilities. The implications of using concept maps in STEM education are profound, offering benefits that extend beyond mere knowledge retention to include enhanced thinking, creativity, collaboration, and adaptability among students. These findings advocate for the strategic integration of concept maps into educational practices to foster a more innovative and effective learning environment.

Keywords: concept mapping; STEM education; creative thinking; Education 5.0

Investigating Inclusive Teaching Practices and Perception Among Engineering and Technology Students   1136–1148
Fengchang Jiang, Haiyan Xie, Sai Ram Gandla, San Lu, Quanbin Shi and Rubing Liu

With the advancements of diversity and inclusion in higher education, a structured mechanism is urgently needed for inclusive teaching practices in diverse learning environments. This paper examines the impact of inclusive teaching practices and the presence of diverse role models on students' perceptions of Diversity, Equity, Belonging, and Inclusion (DEBI) in higher education, particularly among engineering and technology students. It seeks to provide a nuanced understanding of how these factors shape student experiences and perceptions of inclusivity and belonging within academic settings. The identified key strategies can help institutions enhance their DEBI efforts through improved teaching practices and diversity. A mixed-methods approach was employed, combining Bibliometric Analysis and questionnaire surveys as quantitative data and interviews as qualitative data for a comprehensive analysis of DEBI perceptions. The survey was distributed to a diverse sample of students (n = 82) across different programs, portraying their perceptions of inclusivity and the presence of diverse role models. Exploratory and Confirmatory Factor Analyses were used to identify and confirm key factors influencing DEBI perceptions. Four major influences were identified, namely education background, DEBI experience at work, educational experience and needs, and the improvement of DEBI initiatives in industries. This paper discussed effective pedagogies for inclusive teaching practices (e.g., experiential learning methods) and key factors that shape perceptions of DEBI in higher education. By addressing these factors, institutions can develop more inclusive educational strategies that reduce barriers and promote inclusion and equity across diverse student populations.

Keywords: inclusive pedagogy; role models; STEM education; bibliometric analysis; experiential learning; engineering education diversity equity

The Effects of Inquiry-Based Learning on Students' Learning Performance: A Meta-Analysis   1149–1159
Wei Yuan, Xuetan Zhai, Huiling Liu and Qiang Wang

In the recent decade, many educators and researchers have employed Inquiry-Based Learning (IBL) to enhance students' learning performance. While extensive empirical studies have explored the impact of IBL on students' learning performance, the conclusions drawn from these studies are not always consistent. This meta-analysis study provides a comprehensive evaluation of the effects of IBL on students' learning performance. The analysis consists of 22 educational experimental and quasi-experimental studies with a total of 33 effect sizes samples published between January 2013 and June 2024. The results revealed that IBL significantly improved students' learning performance with a medium effect size (g = 0.574). Furthermore, this study investigates the impact of six moderating variables on the outcomes: inquiry types, participants, activity goals, inquiry tools, inquiry environment, and inquiry methods by the application of activity theory. The results indicated that activity goals significantly moderated students' learning performance. These findings support the use of IBL to improve learning performance especially in high school and college engineering education.

Keywords: inquiry-based learning; learning performance; meta-analysis; activity theory; science education

Redefining Engineering Work: How Recent Engineering Graduates Classify Their Roles, Occupations, and Competencies   1160–1173
Samantha R. Brunhaver, Cheryl Carrico, Holly M. Matusovich, Rachel L. Kajfez, Susan Sajadi and Sheri D. Sheppard

Engineering practice is inherently sociotechnical, yet perceptions of the field often prioritize technical skills over professional competencies. This study explores how recent engineering graduates (REGs) define and navigate their roles, focusing on their self-identifications of engineering versus non-engineering work and the key competencies required in their positions. Using a mixed-methods approach, data were collected from 484 survey participants and 30 interview participants across four U.S. institutions. The

findings reveal a disconnect between job titles and self-perceptions, with many REGs identifying as engineers despite their roles being classified otherwise under traditional frameworks. REGs associated technical competencies with engineering and professional tasks, such as communication and management, with non-engineering work, highlighting a technical/social dualism. However, they recognized the importance of both skill sets, emphasizing the need for inclusive definitions of engineering that integrate technical and social dimensions. These insights inform strategies for curricular reform, workplace practices, and research to better align engineering education with the interdisciplinary demands of modern practice.

A Review of Methods for Teaching Automata Theory and Formal Languages 1174–1194

Marina Prvan, Robert Rozić and Duje Čoko and Josip Musić

Automata theory and formal languages are fundamentals of computer science theory but present significant challenges to students and teachers due to the complex and abstract nature of the teaching material. This paper provides an overview of the current methods used to teach these abstract subjects, focusing on innovative approaches that enhance student engagement and understanding. Hence, the main target of the review is the analysis of state-of-the-art research on this topic, classifying the efforts of many educators on how to make the learning environment more accessible and enjoyable for teachers and students. A list of different types of teaching methods instead of the traditional approaches has emerged from the conducted review, i.e. activity-based teaching, visualizations and simulator tools, programmed instructions and programming-based approach, mobile applications, intelligent tutoring systems, teaching by playing or designing games, and using chatbots and artificial intelligence to improve learning results. A comparative analysis of these methods is provided, summarizing key insights and providing resources for educators seeking to adopt more effective teaching practices. Besides the summarized findings from the selected articles, this paper also presents teaching guidelines for each method type, discussing their characteristics and the corresponding challenges when used in the classroom. Finally, the gaps in the current literature are revealed, and future research directions are proposed to inspire researchers to continue the development in this field.

Transversal Competencies and Demands of Engineering Education: Literature Review and a Case Study 1195–1205

Novak Simin and Petar Vrgović

Modern demands of the labour market have requested higher engineering institutions to start equipping graduates with transversal competencies. These so-called "21st-century skills" enable workers to navigate different working environments and can apply to a vast number of professions. This work examines the literature regarding the development of said skills and their relation to engineering education which is responsible for providing the market with work-ready professionals. Sixty-seven papers that examine the influence of transversal competencies have been reviewed to provide current state-of-the-art from the literature. Active learning methods such as project-based learning and problem-based learning, have been shown to act as crucial in enabling this endeavour. A study at the Faculty of Technical Sciences, at the University of Novi Sad, highlighted the need for broader implementation of such methods, as well as a greater need for addressing the development of transversal competencies to adjust the educational offer and respond to the labour market demands. This study was cross-validated, through a questionnaire, with the perceptions of 169 engineers and 80 managers.

Contextualization of a First-Year Engineering Teaching Assistant Personality Instrument 1206–1224

Andrew H. Phillips and Krista M. Kecskemety

Teaching Assistants (TAs) play a crucial role in first-year engineering programs, supporting students as they learn foundational concepts and adjust to college life. Personality influences classroom interactions, yet while teacher and student personalities have been studied, little is known about how TA personality manifests in first-year engineering classroom contexts. Through the theoretical framework of Personality Typing, this study uses the Five-Factor Model (FFM) of personality to create a contextualized and validated instrument for the measurement of personality types in TAs in first-year engineering classrooms: the First-Year Engineering Teaching Assistant Personality (FYETAP) instrument. This paper presents the first phase of development, focusing on contextualization and establishing face and content validity. We used face validity (n = 5 reviewers) and content validity (n = 7 reviewers) metrics to reduce the 100-Item FFM down to 90-Items. Face validity scores were consistently high; therefore, content validity guided item reduction. While most items met established thresholds, whole-scale content validity was moderate, indicating room for improvement in future development. FYETAP holds promise for evaluating predictive validity with student outcomes, supporting TA self-reflection on classroom-specific personality behaviors, and guiding training efforts by first-year engineering program faculty and coordinators.

Promoting Awareness of Plagiarism and Collusion in Programming via Gamified Pop-up Quizzes 1225–1233

Oscar Karnalim

In engineering education, programming plagiarism and collusion are emerging issues. To inform learners about this, we developed a gamified assessment submission system. Per submission, it simulates similarities and provides information on acceptable and unacceptable practices. While the system is quite effective, learners' awareness might be limited as they were not expected to understand the matter in detail. We expand the system by introducing gamified pop-up quizzes. Each student will be asked a random multiple-choice question per week upon submission. Each correct response contributes to the game points. The approach was evaluated under six quasi-experiments with 424 learners in two academic years. According to our experiments, the quizzes could clarify some aspects of plagiarism and collusion. In introductory courses, learners with such quizzes are more aware of plagiarism and collusion and less likely to be involved in such misconduct. They are also engaged in gamification. The quizzes are still beneficial for later courses, but learners are not engaged with gamification.

Material Science Education Research for Effective Teaching: A Systematic Review 1234–1245

Brandon Carter, Shalaunda M. Reeves, Veronica Caro, Jaquelina Schmittlen-Garbocci and Joanna M. Millunchick

A number of studies and literature reviews have examined the STEM education literature to see whether they are effective at promulgating change. While results illuminate trends in all of STEM, instructors who wish to apply these concepts are within individual disciplines. Given the importance of broadening participation in engineering, it is vital that we review the status of curricular change within the contexts of individual departments. We build upon the work by Henderson and colleagues to conduct a systematic review of peer-reviewed educational research by faculty in Materials Science departments between 2010 and 2023 to determine whether the approaches they describe are likely to affect change in the classroom. Most of the reviewed articles describe "prescribed" approaches, which Henderson found does not promote change in educational practices. Furthermore, discipline-specific researchers based in Materials Science and/or other STEM-related departments are less likely to use existing literature and theoretical frameworks. For these reasons, despite the large investment in educational research, the vast majority of education literature in Materials Science is unlikely to promote effective change.

A Multi-stage Modelling Approach to Understand and Evaluate Task Complexity in STEM Context: A Case Study 1246–1260
Vytautas Štuikys, Renata Burbaitė and Mikas Binkis

Task complexity is an umbrella term highly influencing the human-system interaction. In STEM educational research, there are still limited efforts to evaluate task complexity systematically. This paper presents a multi-stage modelling methodology to analyze and evaluate task complexity systematically within the integrated STEM education context, where design, engineering and computer science (CS) are the focus. The core contribution of the paper includes: (i) A multi-stage modelling approach that integrates conceptual, structural (feature-based), and process-based task models to create the aggregated meta-model for obtaining the relationships among STEM task characteristics and complexity measures. (ii) Empirical evaluation of task complexity in STEM-driven CS education using real-world tasks for beginners. The study applies quantitative metrics (for size, time, etc.) and qualitative ones (training, experience, knowledge, etc.) evaluated using the Likert scale for the calculation of the correlation matrix that enables the reveal of relationships among complexity metrics and their impact on overall task complexity.

Keywords: STEM task complexity; task complexity measures; complexity metrics; modelling; STEM education; learning through design

The Impact of an Engineering Teaching Apprenticeship Program on Graduate Students' Professional Pathways 1261–1270
Andrew Bartolini, Kerry Meyers and Victoria Goodrich

A first-year engineering teaching apprenticeship program was established in 2009 and has been active for 15 years. The program has had 2–5 graduate students each year, resulting in over 45 participants. This study focuses on the career pathways of those student participants after graduation, the types of professional roles they selected upon degree completion, and the program's influence on that pathway. The study involves surveying all former participants and studying LinkedIn profiles to determine professional pathways. Results show that most participants in the First-Year Engineering Teaching Apprenticeship Program (FYETAP) had aspirations of being professors and identified the program as an opportunity to gain experience or improve their teaching. After graduation, participants in the FYETAP had placements in academic tenure track and teaching fields at a much higher rate than the overall population of graduating Ph.D. students. Furthermore, most participants whose first jobs after graduating were either teaching faculty or tenure-track positions at a non-R1 university remained in that position for their first three jobs after graduating. Finally, respondents noted that the program confirmed and/or reinforced their enjoyment of teaching, provided more confidence, and positively affected their ability to secure a job after graduation.

Keywords: engineering graduate students; academic pathways; professional preparation

Design and Development of a Low-Cost Shell-and-Tube Heat Exchanger Module for Thermo-fluids Engineering Education 1271–1288
Mohammad Robiul Hossan, Aminul Islam Khan, Talodabiolorun A. Oni, Md. Shariful Islam, David B. Thiessen, Olusola Adesope, Jacqueline Gartner, Bernard J. Van Wie and Prashanta Dutta

Hands-on, active learning in engineering courses fosters deeper understanding, collaboration, and social skills for students. This paper reports on the design, fabrication, and testing of a transparent miniaturized shell-and-tube heat exchanger module for engineering thermo-fluids classes. This module was also implemented for in-class heat exchanger instruction, where students (sample size, N = 75) conducted hands-on experiments following the instructions provided in the associated worksheet, participated in pre-tests and post-tests, analyzed the experimental data, and provided their feedback through motivational surveys. The performance test data obtained from the developed desktop heat exchanger module shows that the experimental heat transfer rates are in good agreement with theoretically predicted values calculated based on the standard correlations and assumptions. The pre-test and post-test assessments show that the use of this miniaturized shell-and-tube heat exchanger module in classroom instruction improves fundamental understanding of the heat exchange process and enhances student comprehension of complex phenomena of fluid flow patterns and heat transfer in the different parts of the heat exchanger. The motivational assessments demonstrate the module's efficacy in elucidating the underlying heat transfer mechanisms and facilitating active engagement. The developed low-cost, hands-on heat exchanger can be used in undergraduate thermo-fluids engineering education for visualizing and better understanding of heat transfer principles, enhancing engagement of students, improving retention of fundamental concepts, and finally bridging the gap between theoretical abstractions and real-world applications.

Keywords: heat exchangers, shell and tube, desktop learning modules, active learning

Teamwork Interactions and Cultural Orientations of Software Development Teams 1289–1307
Jorge Cristancho Rodríguez, Sakhi Aggrawal, Devang Patel and Alejandra J. Magana

Effectively facilitated teamwork allows students to learn from each other, regulate their learning as a team, provide feedback to each other, and challenge each other's thinking based on each student's upbringing. This multi-methods design study explores the students' perceptions of their learning in teams, work contributions, and cultural orientations in an undergraduate software development course at a large university in the Midwest. We evaluated the perceptions of 157 undergraduate students allocated in 31 teams of 4 to 5 members. Findings from the study suggest that cultural orientations do not predetermine their teamwork effectiveness. Individualistic teams can effectively deliver outcomes, but at the cost of limiting the rich potential of diverse perspectives and the collaborative benefits that effective team processes offer. Early identification of divergent cultural orientations, especially in communication styles, enables instructors to implement targeted interventions before team conflict escalates. Fostering intercultural competence is essential for effective teamwork interactions and outcomes in diverse engineering classrooms. Further research is needed on the impact of people-oriented versus activity-oriented teams, particularly regarding balanced workloads and process-outcome effectiveness.

Keywords: teamwork; STEM education; cultural orientations; intercultural competence; multi-methods

International Co-teaching Experience in the NextGEng European Project: A Contribution to Engineering Education 5.0 1308–1318
Silvia Satorres Martínez, Diego Manuel Martínez Gila, Elisabet Estévez, Rubén Dorado Vicente, Tarja Moilanen, Ciprian Rad and Ciprian Lapusan

Engineering Education 5.0 is a new educational paradigm that transcends the development and application of technology, as it also considers ethical issues. Key features that characterize the paradigm are included: collaboration and knowledge sharing, involving international experiences, project-based learning activities, multidisciplinary and technology supported learning-teaching methods. The European project International Cooperation Framework for Next Generation Engineering Students (NextGEng) shares these features to develop a framework for international cooperation in education. As part of this project, new pedagogical methods together with tailored learning materials for existing courses in the curricula are created, aligned with the principles of this new paradigm. This paper presents the co-teaching program developed within the Industrial Automation course as part of the NextGEng project. The methodology involved forming co-teaching teams with teachers from three universities and expert from three companies. Findings indicate positive evaluations from participants, especially concerning the knowledge and skills gained during laboratory sessions. The results demonstrate the potential of international co-teaching and the Engineering Education 5.0 paradigm in enhancing engineering education.

Keywords: Engineering Education 5.0; university-industry cooperation in engineering education; international co-teaching; experiential learning; industrial automation

Potentialities and Constraints of Joint European Degrees in Engineering: Stakeholder Perspectives from the JEDI Project 1319–1330

Nilüfer Ülker, Ramón Martínez Rodríguez-Osorio, Lucía Linares Diamant, Andrés Díaz Lantada, Julien Maheut, Pierre Beauseroy and Thibaut Skrzypek

Recent decades have witnessed various transformational initiatives for the harmonization of European higher education, Joint European Degrees (JEDs) representing one of the cornerstones. With its pioneering role in the establishment of Joint European Degree Label as a step towards JEDs, the JEDI Project, with its specific focus on engineering, has offered a model label with the participation of European University Alliances. This paper explores the potentialities and constraints of joint European degrees in engineering as perceived by multiple stakeholders associated with the industry, ministries, engineering, higher education, and accreditation. It employed a qualitative research design in which data was collected through focus group interviews and analysed through thematic analyses, revealing four overarching themes: (i) label and degree, (ii) quality assurance and accreditation, (iii) added value, promotion and recognition and (iv) long-term vision. Considering the potentialities and constraints of joint European degrees as discussed in this paper will provide guidance for practitioners and policymakers on their design and implementation.

Keywords: accreditation; engineering education; Joint European Degrees; Joint European Degrees in engineering; stakeholders

The Impact of a First-Year Engineering Major Discernment Initiative 1331–1341

Kerry Meyers and Andrew Bartolini

A long-running first-year engineering program at a medium-sized, Midwestern, private university formally introduced first-semester engineering intent students to the different engineering majors available for future study. This involved: (1) hands-on activities related to each engineering department, (2) department choice sessions, and (3) exploration of engineering clubs and activities, all of which culminate in an individual reflection paper. This study is focused on comparing outcomes between students who did not have discernment in the curriculum (2014–2016) and those who did have discernment integrated into their first-year program curriculum (2017–2024). The outcomes presented relate to: (1) the perceived helpfulness of the First-Year Engineering Program in exposing students to different engineering disciplines available, (2) the number of engineering students changing their major during the first year, sophomore year, and beyond, (3) student satisfaction with their major at the time of graduation, and (4) full-time position placement at graduation. This study is based on self-reported student data and institutional records for the student's field of study and job placement. The results from this single-institution study show that first-year students value integrating engineering discernment activities into the curriculum. Doing so increases retention in engineering overall and reduces the number of late major changes (beyond the first year). Finally, considering the longitudinal implications of introducing discernment in the first-year, seniors report higher satisfaction with their engineering major. They are also more likely to take an engineering-related job at graduation. Formal discernment in the first-year was found to have both immediate and long-term benefits for students and the institution.

Keywords: first-year engineering; discernment; major selection; job satisfaction; retention

Shaping Engineering Technology Students' Perceptions of Manufacturing Through Experiential Learning in a Flipped Classroom – A Case Study 1342–1349

Rustin Webster

This study examined how an introductory, survey-based manufacturing systems and processes course – which uniquely integrated a flipped classroom structure and multiple experiential learning elements – influenced engineering technology (ET) students' perceptions of careers, workforce expectations, workplace dynamics, and essential industry skills within manufacturing. Pooled qualitative data from 52 ET student's pre- and post-course reflection surveys, administered across four cohorts, were analyzed using topic modeling, sentiment analysis, comparative assessments, keyword frequency analysis, and/or impact assessment. The data offered valuable insights into students understanding of essential job skills, definitions of a good job, and perceptions of factory work. Before the course, students often associated factory environments with monotony and outdated stereotypes. However, post-course responses indicated a greater appreciation for modern, technology-driven manufacturing settings (i.e. Industry 4.0), workplace governance, and career growth opportunities. The results underscored the role of experiential learning in reshaping students' industry perceptions and improving workforce readiness. By integrating real-world observations and hands-on engagement, this case study highlighted the continued need for curriculum strategies that aligned ET education with evolving industry demands.

Keywords: flipped classroom; experimental learning; industry tours; engineering technology; manufacturing; qualitative research

Understanding Well-Being Among Graduate Engineering Students: The Role of Social Capital and Language Proficiency 1350–1360

Alejandro Baquero-Sierra, Cristian Vargas-Ordónez, Jacqueline McDermott and Stephen M. McBride

Graduate students in the United States face significant challenges to their psychological, psychosocial, and emotional well-being, which are exacerbated by academic demands, financial pressures, and social isolation. International graduate students also encounter additional stressors, such as cultural adjustment and language barriers, which impact their sense of belonging and academic performance. This study explores the predictors of well-being among domestic and international engineering graduate students, specifically in engineering disciplines, utilizing Seligman's PERMA model (Positive Emotion, Engagement, Relationships, Meaning, Accomplishment) as a framework. Key predictors include English language proficiency (ELP), dimensions of social capital (relational, structural, and cognitive), and student-centered institutional support. A survey of 218 graduate students revealed that relational and structural social capital, institutional support, health, and emotional regulation significantly contribute to well-being. At the same time, negative emotions and loneliness detract from well-being. Interestingly, while ELP alone was not a significant predictor, ELP's interaction with international student status highlights how linguistic challenges shape well-being in engineering graduate programs. The findings emphasize the importance of fostering supportive academic environments, promoting intercultural communication, and addressing language barriers to enhance well-being. Recommendations include targeted interventions, such as mentoring programs, emotional regulation strategies, and culturally sensitive institutional policies, to create inclusive spaces that enable graduate students to excel academically and personally. Limitations and directions for future research, such as the need for longitudinal and cross-disciplinary studies, are discussed.

Keywords: well-being, social capital, English language proficiency, graduate engineering students, international students

Educating Outstanding Engineers in the New Era: A Study of Engineering Plans of Study in China 1361–1375

Xiaoye Ma, Mengling Wang and Xiaofeng Tang

As one of the most important policy initiatives in China's engineering education, the Plan for Educating and Training Outstanding Engineers (PETOE) helped establish a wide range of exemplary programs that strived to demonstrate world-class engineering education. In this paper, we analyze engineering plans of study as a way to understand the impact of the PETOE initiative on engineering teaching and learning in China. Through analyzing published research on plans of study prior to and during the implementation of PETOE, we summarize the evolving characteristics in four aspects of engineering plans of study – program objectives, curriculum and instruction, co-curricular learning, and assessment – over the course of the policy initiative. We find that PETOE brought about systematic changes to the objectives, processes, methods, and outcomes of engineering education in China. We reflect on further areas of innovation as China responds to global and domestic demands of engineering learning and professional practice.

Keywords: engineering plans of study; engineering education in China; educational policy

Essential Soft Skills for Engineering in Industry 4.0: A Systematic Literature Review 1376–1385

Tri Adi Prasetya, Sudji Munadi, Thomas Sukardi and Andri Setiyawan

Job competition in the era of Industry 4.0 is becoming increasingly intense, driven by the replacement of certain roles with artificial intelligence, automation, and robotics. To remain competitive in this evolving job market, individuals must possess distinguishing qualities, particularly strong soft skills. This systematic literature review analyzes 27 Scopus-indexed articles published between 2019 and 2024 to identify the essential soft skills needed in engineering. The review highlights six emerging soft skills that are critical for success in the engineering field: communication, teamwork, problem-solving, leadership, critical thinking and decision-making, and creativity. The discussion explores the importance of these skills in enhancing employee performance, particularly in mechanical engineering. The findings underscore the need for educational institutions, especially those focused on vocational training, to equip future graduates with soft skills that are aligned with the demands of Industry 4.0.

Keywords: soft skills for work; engineer soft skills; soft skills 4.0; vocational education; engineering education

Exploring Key Factors for Promoting International Education in Vocational High Schools in Taiwan 1386–1396

Wen-Jye Shyr, Shang-Hao Cheng and Hung-Ming Liau

This study aims to explore key factors for promoting international education in vocational high schools in Taiwan. The research methodology involves literature review and analysis, expert review, and the Delphi method. Experts from relevant fields were invited to provide feedback through expert questionnaires, interviews, and qualitative research. The Delphi expert group was composed of university experts and scholars (N = 5), technical high school administrators (N = 5), and teachers (N = 5) totaling 15 experts to serve as members of the questionnaire team. Three main dimensions of the first layer have been developed: planning, implementation, and promotion. The second layer includes 11 sub-dimensions, including 3 for planning, 5 for implementation, and 3 for promotion, totaling 52 items under each sub-dimensions. The key factors of vocational high schools in promoting international education analyzed in this study can provide reference guidelines for teachers in promoting international education.

Keywords: vocational high school; international education; key factors; Delphi method

Development of a Framework for Complex Problem Solving Based on Perceptions of Engineering Students and Teachers 1397–1407

Ji Yu, Anqi Ma and Wangqi Shen

Complex problem-solving (CPS) is a crucial skill for future engineers. As social, cultural, and technical factors become increasingly intertwined, the challenges confronted by engineers are growing in complexity. How to cultivate this competency through university education has become a key concern for educators. This study conducted semi-structured interviews with eight teachers and twenty-four students to explore their understanding and experiences regarding the concept of CPS competency. It revealed discrepancies between the ideal educational gains envisioned by teachers and the actual experiences of students. Additionally, the study developed a multi-level framework for CPS competency cultivation, which reveals the differentiated value and interrelationships of various courses and learning activities. Furthermore, the study highlighted the role of extracurricular activities in fostering students' CPS ability. The findings suggest that university education should pay greater attention to the gradual development of students' CPS competency, redesign curriculum structure and course content to align with students' skill development, and take into account the cognitive load imposed by CPS training.

Keywords: complex problem-solving; curriculum; multi-level framework; teachers' and students' perspectives

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