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Welcome Message

On behalf of the organizing committee, Welcome to IACEE 2024!

This year marks the 19th IACEE World Conference. This genuinely global forum organized this year by the Institute for the Future of Education, its IFE Europe office, and Tecnologico de Monterrey brings together many academic leaders, university professors, and industry partners under one forum.

Prepare to be inspired by our program, which features 3 keynote lectures by world-renowned experts, 3 round panels, 2 workshops, and 9 parallel sessions. The technical program boasts 36 Extended Abstracts and a Special Issue in the Leadership on Education Section of the Frontiers in Education Journal.

The IACEE 2024 conference gathers over 60 participants from 30 countries on 5 continents. We are confident that IACEE 2024 will be an enriching educational and informative experience for all participants as we continue to provide high-quality technical content with participation from continuing engineering education leaders worldwide.

This year, we are pleased and honored to host the IACEE Council Board Meeting, which gathered 21 members over two days. In addition to the main conference, IACEE 2024 features two pre-conference workshops.

IACEE 2024 has received sponsorship from BCdiploma.

We want to express our deepest gratitude to all the committee members, reviewers, session chairs, special session organizers, workshop organizers, and, most importantly, the authors. Your contributions are the lifeblood of our conference, and we are truly grateful for your trust and support.

The conference is held at the Seminario Mayor de Comillas, a historic venue renowned for its stunning architecture and rich academic heritage. It offers the perfect backdrop for our conference dedicated to innovation and excellence in Continuing Engineering Education. Enjoy the conference!

On behalf of the organizing committee,

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Extended Abstracts

Authors

A Case Study on Constructing a Viable Organization Using Operational Excellence Methods for an Engineering Professional Education Department

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CONTEXT

Beginning in 2019, the McKelvey School of Engineering Professional Education unit embarked on an effort to put the unit on a firm operational footing and set the stage for increased vitality and prosperity.

KEYWORDS: Viable System, Organizational Cybernetics, Operational Excellence, Lean, Six Sigma, Process Improvement, Engineering Continuing Education, Higher Education.

PURPOSE OR GOAL

This case study focuses on:

- How a viable system cybernetic feedback model can contribute to the conceptualizing of ways to advance organizational performance.
- How the use of operational excellence methods can improve professional education operations.
- How a well-developed strategic plan can drive enrollment and tuition growth and cultural change.
- How data-driven decision-making and tracking can help ensure performance and progress toward goals stay on track.

APPROACH

Any system, in this case an organization, if it is to survive must be able to meet the demands of the changing environment in which it operates. Viable systems exemplify just such adaptability because the internal structure exhibits the requisite variety to match the surrounding environment and internal operations are structured in a way that effectively transforms inputs into desired outputs. A viable system consists of:

- Optimized functions and processes
- Robust information flows
- Clear roles, policies, rules, resources, and authorities
- Outward-facing environmental scanning capabilities
- Strategic direction and decision-making
- Emphasis on individual autonomy which requires:
  - Excellent people who are skilled, expert, and committed to their roles
  - Two-way trust
  - Continuous communication, feedback, and adjustment
- A culture that is supportive and embraces a continual improvement mindset

As a set of tools, operational excellence is employed to organize processes to effect continuous improvement across all aspects of the enterprise and within all business processes by creating a culture where management and employees are invested in business outcomes and empowered to implement change. Although OpEx originated in the manufacturing industry, its principles can be applied profitably to all sectors, including higher education.

We used the viable system construct as a mental model to guide our operational excellence efforts. These included the development of a transformation strategy, extensive process mapping, delineation of business metrics, and culture change initiatives.

OUTCOMES

Given the clear-cut impact of this department-wide change management effort, in 2021 school leadership elected to conduct a study of its professional education operation, including the examination of for-credit and non-credit programs to determine if and how to proceed in terms of investment and staffing. The recommendations from this study resulted in a “Prof Ed 2.0” strategy to 1) invest in the McKelvey Professional Education unit to create baseline growth, 2) grow and add part-time graduate programs, 3) evolve the Professional Education Unit’s non-credit training arm into the non-credit innovation engine for McKelvey, and 4) build on and establish new industry partnerships.

Although Prof Ed 2.0 is in its initial phase, the strategy is already starting to bear early fruit. The work resulted in many positive outcomes, including:

- Additional enrollments and increased revenue.
- Enhanced, ongoing awareness of the external competitive environment.
- Increased clarity on core processes and functional “swim lanes”.
- Better teamwork.
- Improved operational and process efficiency.
- Data-driven decision-making.
- Greater agility and responsiveness and faster operational pace.
- A culture characterized by follow-through, initiative, trust, open communication, empowerment, and innovation.

To assure ongoing operations effectiveness and progress toward implementation of the Prof Ed 2.0 strategy, the Professional Education unit takes a data-driven approach using a tailored set of metrics tied to outcomes and performance wherein all team members understand their role in the unit’s success and work together to achieve the unit’s goals.

CONCLUSIONS

At least in this case, but also supported by numerous examples in the literature, the thoughtful implementation of operational excellence methods generates a wide range of positive outcomes for organizations. One should account for and not underestimate the institutional drag that manifests in organizational change efforts. The importance to individual psychology in the commitment to and undertaking of change is vital. Without it, such efforts will go off the rails or fail.

Concomitantly, the social psychology of the team must be such that each member supports and encourages the other toward the desired end state, to include intermediate objectives and tasks large and small.

Measuring performance is a task that can be easily overlooked, but is essential to ensure that operational excellence initiatives have the intended effect and that the organization stays on track toward the desired end state (achievement of strategic goals).

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A Novel Taxonomy for Continuing Engineering Education

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CONTEXT

The dynamic landscape of education and the professional workforce demands an innovative response to global events such as the COVID-19 pandemic, the massive incorporation of artificial intelligence tools, the diffusion of digital education, and the unexpected shifts in jobs, roles, and occupations in every segment of the workforce. According to the 2023 Future of Jobs of the World Economic Forum, 44% of workers' core skills are expected to change in the next five years, and engineering is identified as one of the most common occupations with labour shortages **(World Economic Forum 2023)**. Global challenges and factors like climate emergencies and the precarious social and economic situation of refugees and migrants have propelled economic changes, with 18 million more jobs related to the green transition expected to be created worldwide in our effort to achieve the Paris Agreement **(International Labour Organization 2018)**. These developments highlight the need to boost our continuing education and lifelong learning systems and adapt them to be more diverse and agile. The timely and efficient capacity building of professionals and employees is becoming a priority in many countries, not only to ensure that no one is left behind in this era of great transformation but also that the labour market has the skills needed to meet the needs of this new economic, environmental, and social setup. Although influenced by unique country-specific contexts, governments, and educational institutions actively seek appropriate responses to these challenges, often in isolation and without a clear guide to designing their continuing education and lifelong learning systems in the best way. This study builds upon a 2023 comparative analysis of Continuing Engineering Education (CEE) at diverse universities in different countries, emphasizing the necessity for a standardised language to facilitate cross-country and cross-institutional knowledge sharing.

KEYWORDS: Continuing Engineering Education; Taxonomy; Lifelong Learning; Framework; Lexicon.

PURPOSE OR GOAL

No taxonomy, framework, or standardised vocabulary exists for comparing and managing CEE learning programmes and interventions. In the context of this research, a framework is taken to be a system of classification that can categorize and organise how institutions and programme teams organise and deliver CEE. Additionally, there are limited conceptualizations around frameworks and taxonomies in Continuing Education (Jarvis 2004; 1996) and recognition of the complexities in developing such taxonomies, as well as being focused on the learning [micro-level] activities rather than institutional decision-making (Lindsay and Richard 1972). This paper addresses this gap by introducing a framework around CEE models, focusing on effectively managing these programmes to encourage the exchange of best practices. This

paper aims to unveil a new framework that could be adopted across different countries and continents, highlighting categories such as resourcing (of learning), organizational/business models, and programme development strategies. Additionally, it will provide standard definitions to enable a consistent use of the taxonomic terms. Doing so will facilitate both the knowledge and best practice exchange among actors in CEE and allow them to embark much more quickly on collaborative projects in this space.

APPROACH

The literature non-systematic mapping in the present study was limited to the Scopus and the Web of Science databases and the last ten years (2015-2024). The keywords for the search were ("continuous education" OR "continuing education" OR "ongoing education" OR "lifelong learning") AND (taxonomy OR taxonomies) AND ("adult learning" OR "professional development" OR "skill development"). A total of 68 documents were analysed with the following document distribution: CEE, 24; Workforce Education, 15; Continuing Education, 14; Lifelong Learning, 8; Professional Development, 7.

A sequential, inductive, qualitative approach, inspired by the work of Finnelli et al., has been used to develop the framework (Finelli, Borrego, and Rasoulifar 2015). Initially, the eight co-authors used a comparative case study approach (Bartlett and Vavrus 2017). An initial set of meso-level factors was co-developed through an iterative discursive process between co-researchers. The co-researchers took the meso-level in this context as organizational strategic factors (whether universities or private education/training providers), such as how to resource CEE offerings and organizational strategies and policies. Meso-level was chosen as a focus as this was identified as the most challenging area to compare practices; macro drivers were most consistent across levels (and with extant macro-economic models), and micro-factors are dependent on specific institutional practices (and relate to teaching and learning where existing taxonomies and frameworks exist).

The taxonomy's first version was developed to facilitate a more straightforward comparison between CEE practices (version 1.0). A limitation of this original framework was that it was based on a convenience sample of institutions (one per country), and the co-researchers recognised a diversity of institutions and offerings in their own countries. So, a further phase of refinement and validation was required. Subsequently, the first version of the taxonomy was shared and discussed with participants with knowledge of CEE approaches at a range of other institutions, with participants allowed to review, refine, and add to the taxonomy (version 1.1).

A limitation of this research is that it is mainly European-focused, with a specific scope on the meso-level within academic-only institutions. The intention is to use the IACEE conference to share, discuss, and further refine the framework with a broader range of participants (non-academic institutions, different countries, and continents).

ACTUAL OR ANTICIPATED OUTCOMES

The output of this study will be a standardised framework for discussing and comparing CEE institutional approaches and practices to advance the field and foster a global IACEE community committed to excellence in engineering education. Figure 1 outlines the current version of the taxonomy that highlights the meso level. Key decision areas were 1) the Organizational approach to offering CEE, 2) how CEE was resourced, 3) the types of CEE offering supported, and 4) the market alignment of CEE offerings. Additionally, an accompanying lexicon offering standard definitions will be provided.

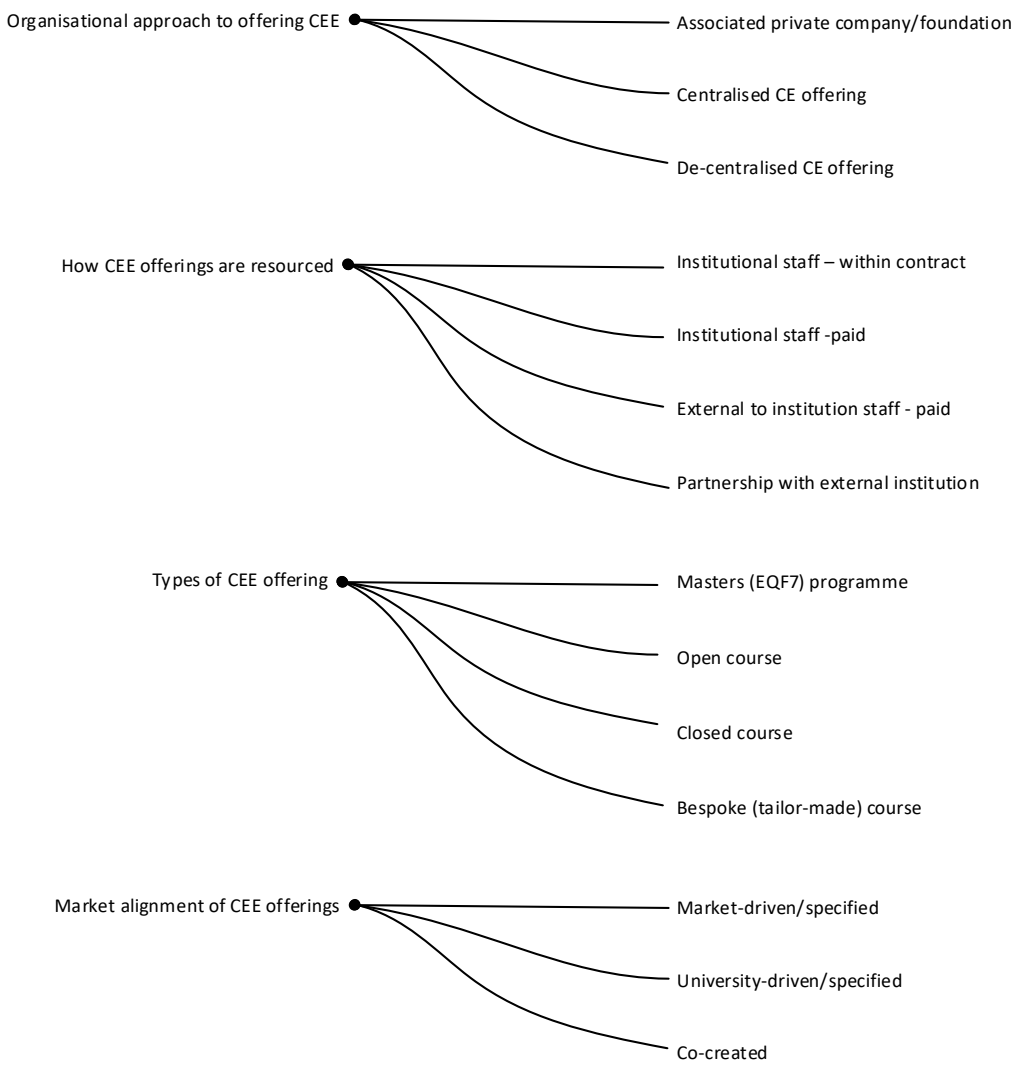

Figure 1: visual representation of taxonomy (version 1.0).

CONCLUSIONS

The need for a standardised lexicon to allow practical discussions and collective progress in Continuing Engineering Education has created a novel taxonomy with associated definitions. This taxonomy at a meso-level (institutional decision-making) will support more efficient sharing of practices and meet the demand to support engineers in re- and up-skilling to meet the current and ongoing learning needs. Likewise, the taxonomy can help institutions to benchmark current practices to foster the development of policies.

ACKNOWLEDGMENT

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Are University Continuing Engineering Education Divisions and Industry Learning and Development Units Ready for Industry 5.0?

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CONTEXT

Industry 4.0 has brought about significant changes in the manufacturing sector, integrating advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and robotics. As we move towards Industry 5.0, which emphasizes sustainability, human-centricity, and resilience, it is crucial to examine the readiness of university continuing engineering education divisions and industry learning and development units to meet the demands of this new era [1].

Industry 5.0 is expected to bring about a paradigm shift in how industries operate, focusing on creating value for society and the environment while prioritizing workers' well-being [2]. This shift will require engineers to develop new skills and competencies and take a collaborative approach between universities and industries to prepare the workforce for the challenges and opportunities of Industry 5.0.

PURPOSE

The purpose of this study is to investigate the strategies and approaches that university continuing engineering education divisions and industry learning and development units can adopt to prepare engineers for the unknown world of Industry 5.0. The research questions guiding this study are:

1. How can these units develop training courses and curricula to prepare engineers for emerging technologies and jobs quickly?
2. What university-industry collaborative approaches can propel Industry 5.0 education?
3. How can these units strategize the upskilling and reskilling of their employees to streamline work using new technologies?

APPROACH

A mixed-methods approach will be employed to address the above research questions. First, a comprehensive literature review will identify the current best practices and perceived gaps in Industry 5.0 education and training. This review will focus on key areas such as emerging technologies, sustainability, human-centricity, and resilience and how they relate to the skills and competencies required for Industry 5.0.

Second, semi-structured interviews will be conducted with key stakeholders, including university faculty, industry professionals, and learning and development managers. These interviews will gather insights into their experiences, challenges, and strategies related to Industry 5.0 readiness. The interview data will be analyzed using thematic analysis to identify common themes and patterns.

Finally, a survey will be distributed to a larger sample of engineers and learning and development professionals to validate the findings from the literature review and interviews. The survey data will be analyzed using descriptive and inferential statistics to identify significant trends and relationships.

This is a work in progress. The World Conference 2024 presentation will focus on the literature study and survey questions development for the second and third sets of work. The conference network will be used to gather data for the second phase of work, with the results driving the third phase of the survey.

ANTICIPATED OUTCOMES

The anticipated outcomes of this study will:

1. Identify key competencies and skills required for engineers to thrive in Industry 5.0, such as systems thinking, interdisciplinary collaboration, and digital literacy.
2. Develop a framework for university-industry collaboration to design and deliver Industry 5.0-focused training programs, including joint curriculum development, industry-based projects, and mentorship programs.
3. Recommend upskilling and reskilling strategies for employees in university continuing engineering education divisions and industry learning and development units, such as personalized learning paths, micro-credentials, and experiential learning opportunities.
4. Provide insights into the challenges and barriers to Industry 5.0 readiness, such as resistance to change, lack of resources, skills gaps, and potential solutions.

CONCLUSIONS

Based on the evidence gathered, this study is expected to highlight the need for a proactive and collaborative approach between universities and industries to prepare engineers for the challenges and opportunities of Industry 5.0. The findings will contribute to the existing knowledge on Industry 5.0 education and provide practical insights for stakeholders to enhance their readiness for this new era.

The study will likely conclude that university continuing engineering education divisions and industry learning and development units must adopt a more agile and adaptive approach to training and development, focusing on emerging technologies, sustainable development, human-centricity, and resilience. This will require a shift in mindset from traditional, siloed approaches to more collaborative and interdisciplinary learning and development models.

Furthermore, the study will again emphasize the importance of lifelong learning and continuous upskilling and reskilling for engineers and learning and development professionals. As the pace of technological change accelerates, it will be crucial for individuals and organizations to embrace a culture of learning and adaptability to remain competitive and relevant in the Industry 5.0 era.

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Building a Sustainable Workforce Accelerator Through the Intersection of Higher Education, Industry, and Critical Thinking

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CONTEXT

New Mexico State University (NMSU), founded in 1888 as the state's land-grant university and a recognized Hispanic Serving Institution (HSI), is leading the path on an initiative titled, EXPAND NM (Economic Prosperity Accelerator for Novel Workforce Development) utilizing expertise within the intersection of higher education, industry, and individuals with vision to create sustainability. As a statewide provider of educational programming, the NMSU system is comprised of the main campus, flanked by three branch community colleges, the NMSU Global Campus, a multi-faceted system-driven Office of Workforce and Strategic Engagement, a network of 12 agriculture science centers, and 33 county-based Cooperative Extension Offices. NMSU Global and the Office of Workforce and Strategic Engagement is a system-wide leader in catalyzing the delivery of new innovative educational programs to support statewide demand for an upskilled, reskilled, and newly skilled workforce. One area that has seen tremendous growth is the utilization of micro-credential courses that leverage the growing demand for micro-learning opportunities.

KEYWORDS: Microlearning, upskilling/reskill, continuous learning, workforce accelerator, modern learning

PURPOSE OR GOAL

As a state, New Mexico is experiencing a dichotomy of economic opportunities and workforce challenges. With record-breaking oil and gas receipts fueling a billion-dollar budget surplus, the state's labor force remains persistently small, with an estimated one-quarter of the state's population unemployed but of working age. Between 1999 and 2021, the state's Labor Force Participation Rate (LFPR) dropped 9 percent for men between the ages of 25-34, nearly double the national average (third lowest after West Virginia and Mississippi), and for women aged 35-44, LFPR dropped at double the national rate at 5.2 percent (fourth lowest after West Virginia, Mississippi, and Alabama)[1]. A November 2022 report by the New Mexico Legislative Council Service (NMLCS) conveys that virtually every aspect of the economy (i.e., social services, economic development, tax rates, pension systems, and service industries) is impacted when fewer people are working to support those who do not work. Echoing a need to pursue recommendations by the National Council of State Legislators to strengthen workforce attraction, retention, and expansion programs to increase labor force participation, the NMLSC estimates that the state could have close to 100 thousand more workers if workforce participation equaled national rates[2].

According to the NM Economic Development Department (EDD) Strategic Plan (Oct 2021) report[3], the Southwest is one of the fastest growing regions in the country, with NM positioned in the middle. However, NM has seen less population and labor force growth than neighboring states. From 2010 to 2019, rates in Utah (16% population and 22% labor force) and Colorado (14% population and 16% labor force) grew more than NM (2% population and 0.6% labor force.) Some identified reasons include available and affordable housing in urban areas and the lack of physical and digital infrastructure in the state's tribal and rural communities. Another reason is a perceived disconnect between higher education and the state's employer workforce needs.

Industries with high employment needs continue to report challenges in recruiting qualified talent, an indicator of a labor shortage or skills mismatch[4]. As further evidence of workforce challenges, NM ranked 40th (876, including new, renewal, and transferred applications) for the number of Labor Condition Applications (LCA) for H1-B Visa Petitions in 2022, with an average salary of $112,739. In 2022, the number of LCAs decreased from 972 in 2021. However, the average salary increased by $5,317 from $107,422 in 2022[5], suggesting a willingness of high-wage employers to provide competitive salaries for high-skilled, high-demand employees.

APPROACH

As a land-grant and Hispanic-Serving Institution, NMSU has adopted a visionary approach to building statewide and global micro-learning courses through a digital storefront. These microlearning offerings are designed to allow employers to verify the skill/competency through the demonstration and mastery of desired skills prior to awarding a verified credential. This approach in continuing education provides education and engagement across a geographically and ethnically diverse workforce. Under the institutional tagline *Be Bold: Shape the Future*, NMSU's core values embrace its land-grant mission of education, research, and public service as an asset and are committed to scaling proven strategies to help shape the state's future workforce. The primary goals of EXPAND NM through continuing education are to (1) provide credential attainment to create a competitive workforce in NM, (2) foster economic opportunity through quality workforce development, and (3) ensure learners remain relevant and competitive in the workforce through in-demand credentials (high-wage, high-demand, highly-skilled – H3 jobs). These goals will utilize tactical strategies to align educational curriculum and training modalities with employer needs while shortening the workplace onboarding post-graduation.

ACTUAL OR ANTICIPATED OUTCOMES

The currently siloed approach between academic degrees and workforce development upskilling, reskilling, and learning a new skill will be the future of higher education. As higher education and workforce development trends continue to move in the same direction, NMSU will be positioned to lead this global effort. NMSU is pushing forward to be at the forefront of this transformation in higher education to better meet the needs of the next generation of learners. The continued positive results of this accelerator could open additional revenue opportunities for the institution and further NMSU’s impact on the state’s residents, employers, and economy. Additionally, the growth will provide the institution with advanced technology (i.e., AR/VR related equipment, iPad Pros equipped with LiDAR scanners, and virtual desktops) and the ability to upgrade equipment for hands-on labs that will allow for the expansion of dual credit opportunities for high school students looking to move into the workforce. In summary, NMSU anticipates the following outcomes:

- Bridge classroom learning with real-world application.
- Reduce the need for high-cost laboratories/equipment/training facilities.

- Increase access to prospective employees through asynchronous learning.
- Reduce occupational health and safety risk through scaffolded integration of VR educational modules before on-site, hands-on training.

CONCLUSIONS

As NMSU develops partnerships between industry partners, expert faculty, and subject matter experts (SMEs), the intersection will see more than microlearning and continued education credit; new learning models will begin to emerge to meet the needs of the workforce, higher education, and the next generation of learners. Scaling microlearning with the workforce accelerator allows NMSU to create the thousands of opportunities waiting for the current silos to be broken down to re-establish the needed collaboration between stakeholders nationally and internationally.

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Characteristics of individual and collective agency in learning communities for the energy transition

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CONTEXT

Education for sustainable development (ESD) empowers learners of all ages to make informed decisions and take individual and collective action to change society and care for the planet (Unesco website). Generic learning programs, such as current CEE programs, insufficiently reflect the needs of employees, their organizations, and the challenges in society (Emanuel, Sijbom, Koen & Baas, 2022). Challenges related to sustainable development, in particular the energy transition, will have to be tackled in a transdisciplinary way, focusing on the ever-changing wicked situation rather than fixed policies and pre-programmed solutions (see e.g. Teisman, 2019). Learning communities (LCs) could be a way to deal with such wicked situations to strengthen agency and capabilities of participants, groups and organizations. In these public private partnerships participants with various backgrounds work together across the boundaries of their organizations to deal with complex issues that entail large uncertainties. This presupposes an agentic role for learners in which they are central mediators of what they experience and how and what they learn. By giving people the ability to exert influence on their own learning process, they feel more engaged and motivated to learn. Agency allows people to pursue their own goals and interests (Wenger-Trayner & Wenger-Trayner, 2020). Therefore we hypothesize, individual and collective agency contribute to more effective LCs.

KEYWORDS: Professional development, lifelong learning, learning communities, individual and collective agency, education for sustainable development.

PURPOSE OR GOAL

In this study, we focus on agency in LCs, both at the level of the participants to pursue personal goals (individual agency) and the level of group(s) in the LC in order to deal with a wicked situations in the energy transition (collective agency). The present study aims to gain insight into the characteristics of both individual and collective agency in a LC. Therefore, the following research question has been formulated: *What are characteristics of individual and collective agency in LCs to deal with wicked situations in the energy transition?*

APPROACH

First, a narrative literature review was performed as an initial step to provide a comprehensive exploration of characteristics of agency within LCs. Second, we interviewed key actors from existing LCs to validate and complement the results of the literature review. Fifteen unstructured interviews were conducted. All existing LCs focused on energy transition and pursued innovation. Each LC consisted of a public-private partnership in which the different partners were mutually dependent on each other to achieve their objectives.

The interviews aimed to assess the applicability of agency characteristics identified in the literature to LCs involved in energy transition. Additionally, these interviews sought to uncover any unique characteristics specific to LCs that may not have been captured in the literature review.

The participants in this study included key actors and stakeholders within LCs involved in energy transition initiatives. Each interview covered one LC. These individuals occupied roles such as facilitators,

coordinators, managers, and researchers, representing both educational institutions and the professional field.

Interview transcripts were analyzed using the qualitative data analysis software, Atlas.TI. The coding scheme used for the analysis was based on the characteristics identified in the literature review, ensuring alignment with existing knowledge. In parallel, open coding was used, revealing new categories.

ANTICIPATED OUTCOMES

The narrative literature review has led to a focus on the Capability Approach (CA). The CA is considered a suitable framework for the analysis of well-being and sustainability. The CA pays attention to both individual and collective agency and capabilities. 'Agency refers to an individual's ability to recognize and utilize opportunities in the environment. This is not only about being able to use the possibilities as they arise, but also about being able to adapt to them or create or make them suitable yourself' (Hoeve, Nieuwenhuis, Verhoef & Van der Werf, 2021, p.18). We found that being active in a LC enabled people to acquire new collective capacities and expand their own capacities, congruent with findings of Ibrahim (2014), and Ballet, Dubois & Mahieu (2007). The CA describes two aspects of freedom: the opportunity aspect and process aspect. The opportunity aspect of freedom refers to the actual opportunities that people have, given their circumstances, to pursue their goals (Sen, 1999; Sen, 2009). The process aspect of freedom refers to the process of choice itself (Sen 2009). Results show that individual and collective agency in LCs that focus on the energy transition, relate to both the opportunity aspect and the process aspect.

Opportunity aspect

Which capabilities (participants of) LCs in the energy transition have, depends on the access of the LC to resources such as human and social capital, tools and time. Social, economic, cultural, political and personal conversion factors determine the extent to which available resources can actually be used. For example, it has a positive effect if organizations that are part of the LC want to pursue social goals and regard working across organizational boundaries as useful. In addition, the participants in LCs are directly affected by structural constraints such as laws and regulations, but also social norms within the community.

Process aspect

The process aspect concerns identifying goals and values, both at an individual and collective level. The role of social interactions between individuals is crucial to achieve common values and commitment. Responsibility, sympathy and generosity encourage people to make a commitment to others (Ibrahim, 2014; Seckler & Volkert 2021). In the LCs interviewed, common goals emerged, such as the urgency of the energy transition. Actions and interactions lead to actual results for the energy transition, organizations and the participants. Knowledge gained is shared with partners and other target groups. Appropriate reflection plays an important role in empathizing with different perspectives and adjusting goals and solutions.

CONCLUSIONS

If characteristics of agency are taken into account, we contribute to well-functioning LCs that in turn contribute to solutions for complex issues in the energy transition and other sectors. Professional development for a sustainable future is one step closer.

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Collaborative approach to re-skilling through quality-assurance of organisational learning in Scotland

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CONTEXT

We are living in disruptive times, whether this is in a post-COVID-19 world, or through rapid changes in technology (such as generative AI) or economic or environmental disruption. These changes are seeing corresponding changes within the job market, with World Economic Forum (2023) indicating that 60% of the workforce will require training over the next 3 years to keep their skills current. Additionally, the workforce is more fluid, particularly millennials who are focused on career development and who do not intend to spend more than three years with an employer (Tenakwah 2021), and value training and development (Work Institute 2020). Consequently, up- and re-skilling are important considerations for both individuals and organisations alike.

Responding to these needs, a greater diversity of opportunities beyond formal education exists for individuals and organisations to support professional development and career transitions; additionally such approaches afford organisations an ability to support the development of employees and volunteers. In recent years, there has seen an increased range of up- and re-skilling providers, from professional bodies, for-profit training providers, employers, third-sector (charity) organisations. This wider range of providers offer more flexibility, responsiveness and inclusivity for learners, which are key enablers to developing a more responsive skills eco-system in Engineering (Royal Academy of Engineering 2023). Moreover, these learning providers are increasingly looking to make their learning provision more portable through quality-assured recognition within National Qualifications Frameworks.

Within the Scottish education system, the Scottish Credit and Qualifications Framework allows for a range of non-educational organisations to have their training evaluated against the five characteristics of the SCQF criteria. This process, called “credit rating,” evaluates the learning (and the assessment of that learning) to indicate the SCQF level of the training, as well as a recognition of the learning hours, so credits based on 10 notional learning hours is one credit within Scotland (SCQF Partnership 2022; Dunn 2022).

KEYWORDS: organizational learning; quality-assurance; re-skilling; Scotland; university-organisational collaboration

PURPOSE OR GOAL

Currently, there is a lack of contemporary evidence around how “credit rating” of learning courses are supporting skills development in Scotland and globally. Therefore, this paper will examine the quality assurance mechanisms and benefits of such a collaborative system of formal learning assessment within Scotland, using one Scottish university (as an approved learning assessor) and learning providers in the digital economy sector. The research question is “what are the benefits of having a flexible national qualification system – Scottish Credit and Qualifications Framework (SCQF) - that allows ‘credit rating’ of organisational learning?”

APPROACH

A desktop review using secondary data was adopted for this research. The review focused on two aspects, firstly to outline the quality assurance mechanisms at the selected Scottish university (and how these align to the national requirements outlined by the SCQF Partnership), then secondly by a case study approach using a purposive sample of digital service organisations that have their learning courses "credit-rated" by one Scottish university. This methodology is adopted as it allows sharing of practices (aligned to one of the conference's expected outcomes).

ACTUAL OR ANTICIPATED OUTCOMES

Firstly, the approach to working with external organisations, and the associated quality assurance mechanisms, will be outlined and how these initially assess the learning and assign both a credit value (notional learning hours and level within the SCQF), and how ongoing audits ensure a quality of learning and learner experience.

After which, a purposive sample of digital services learning that is "credit-rated" will be outlined, including the value that the organisations get from this, as well as the benefits to the university (such as the contribution such an approach makes to widening accessing and participation in learning and supporting society and industry).

Finally, future directions of such collaborations, and how such "credit-rated learning" can fit within a wider eco-system of learning to support agile and inclusive education to support career transition will be detailed.

CONCLUSIONS

The Scottish Credit and Qualifications Framework, as a single integrated framework covering all types of qualifications and skills, creates a structure within which for different forms of learning to be equally recognised. Along with the ability for approved learning assessor to assess and "credit-rate" learning, then a greater potential range of credit-bearing learning courses can exist, that bring value to organisations and support the wider skills transition and transformation. This paper will outline how this works and the benefits that it brings to one Scottish university and to a sample of organisations that have had learning "credit-rated".

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Combining two types of abilities assessment in engineering students: How biometrics enter the framework of Industry 5.0

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CONTEXT

In transitioning from Industry 4.0 to the forthcoming Industry 5.0, this research explores the fusion of the humanistic view and technological developments to redefine Continuing Engineering Education (CEE). Industry 5.0 introduces concepts like biomanufacturing and human-centricity, embodying the integration of sustainability and resiliency principles in CEE, thereby shaping the upskilling and reskilling initiatives for the future workforce (Grodek-Szostak et al. 2020). Industry 4.0 provided the platform for all current concepts related to digitalization and AI-driven technologies. However, Industry 5.0 has appeared on the workforce scene since 2021 to guide research and technological innovation toward integrating social and environmental priorities (Breque and Lars De Nul 2021). Also, this new concept stands out as the influence of industry to reach societal aims, building industrial production respecting the planet's limits and considering the well-being of industry employees at first (Xu et al. 2021).

KEYWORDS: EEG, Industry 5.0, Human-Centered, Neuropsychology, Biometric Assessment, Abilities

PURPOSE OR GOAL

To gain a deeper understanding of the significance of the industry worker´s well-being, it is necessary to explore aspects related to the workforce (Grodek-Szostak et al. 2020). These Aspects are closely associated with the inner dimensions of the human being or measurable psychological features. This study addresses the prevailing skill gap from industry requirements, technological advancements, and labour market shifts (World Economic Forum 2023). Our research is based on recent studies into Knowledge, Skills, and Abilities (KSA) taxonomies (Caratozzolo et al. 2023), linking these elements with dynamic labour market profiles. This work intends to integrate a biometric perspective to conceptualize and describe how abilities could be represented by linking a Neuropsychological test and a biometric assessment.

APPROACH

In order to understand human beings and the impact of their biological development across diverse and changing workplace settings, it is necessary first to comprehend the development of abilities and how they are composed. To achieve this aim, we have conducted several tests on 15 engineering students using the neuropsychological test *Neuropsi* and the *Emotiv insight 2.0*, including an appropriate Brain-Computer Interface (BCI) that allowed the electroencephalogram (EEG) to measure *performance metrics* such as attention, stress, engagement, and excitement (Hammer et al. 2018; Saha et al. 2021). The data was collected while subjects performed memory, attention, language, and executive functions *Neuropsi* test tasks. This allowed us to describe two profiles, one related to the test results and the other related to biometric results (González-Osornio, Medina-Rivera, and Orta-Castañeda 2022; Saldana et al. 2023).

ACTUAL OR ANTICIPATED OUTCOMES

These profiles which were built with BCI and neuropsychological tests are an initial response to the characterization of abilities in our KSA taxonomy. The protocol in this first phase shows two profiles composed of cognitive abilities. The first profile showed the scores of each ability, and the second profile presented a biometric profile corresponding to the subject's performance while doing the neuropsychological test. Coincidences were found in the two profiles. This psychobiological profile intends to approach a human-centered design, allowing greater applicability and usability of these measuring instruments in industry and workforce issues, such as upskilling and reskilling (Shneiderman 2020; Wright and McCarthy 2022).

CONCLUSIONS

Generally, the instruments used in this research are used more in the clinical field, although they are well-curated and standardized. Still, in developing this case study, we consider them a feasible option for implementation in various areas related to human resources, the workforce, and the labor market. It is vitally important to consider that the mind is a construct that involves observing behavioral and biological aspects to obtain a comprehensive vision. For this reason, we consider that by combining the evaluation instruments mentioned in this work, human abilities can be observed and described comprehensively.

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Critical Thinking in Engineering Toward Industry 5.0: Is AI a Tool or a Challenge?

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CONTEXT

One of the main challenges in engineering is providing non-technical skills such as critical thinking, as many of those abilities are sometimes not observed in graduates [1]. This soft skill is included within the 4 Cs of learning for the 21st Century along with creativity, collaboration, and communication [2], and is classified as an important employability skill [3]. In fact, critical thinking, and other soft skills are highly regarded by employers, especially after the revolutionary changes triggered by the global pandemic, yet they are commonly part of the gap between higher education programs and the actual requirements from the industry [4, 5]. In addition to previous changes, 2023 was a disruptive year in which artificial intelligence gained traction and merged with the education process at many levels. This happened in accordance with the current Industry 5.0 concept, in which machines and humans collaborate in different processes, and artificial intelligence can be applied as a tool [6,7]. Nevertheless, soft skills such as critical thinking and creativity are still assets from human beings, with more refined results to those from machines [2].

For those reasons, the acquisition of soft skills in engineers is still necessary, even during the completion of higher education studies. However, with the development of certain AI platforms such as Chat GPT, users can hinder the development of soft skills including critical thinking and creative writing [8].

KEYWORDS: AI, critical thinking, industry 5.0, engineering, soft skills, higher education

PURPOSE OR GOAL

The goal of this work was to assess the effectivity of AI writing detection by different similarity detection services for an argumentative task written is Spanish, as well as proposing alternatives for developing and evaluating critical thinking and other soft skills under the current boost of AI platforms.

APPROACH

A Spanish taught class from the Food Engineering programme (25 learners) at the Monterrey Institute of Technology and Higher Education, was asked to reflect and produce a written opinion about “The importance of effective communication applied in a collaborative work”. This opinion was simultaneously generated by the students as an original piece and as a ChatGPT product. Both results were analyzed with similarity detection services, precisely Unicheck, Turnitin, and GPTZero. Statistical analysis (One-way ANOVA) of the collected data was performed in Minitab 21. Furthermore, based on current research, a discussion about the development of critical thinking considering the AI transformation was proposed.

ACTUAL OR ANTICIPATED OUTCOMES

Both the original and the ChatGPT generated opinions were not identified as plagiarized written documents, as noted by the percentage of plagiarism/similarity identified by Unicheck (Original: 10.14±6.88%; ChatGPT: 14.44±6.88%) and Turnitin (Original: 8.60±4.92%; ChatGPT:12.43 ± 7.85), from which the similarity percentage identified in the ChatGPT reflection by Unicheck was significantly higher than the other values ($p=0.027$). On the other hand, the GPTZero platform could not identify any AI origin with an average of 1.04±1.14%, as all the documents were mainly attributed to human origin (82.52±5.77%) or a mix of human and AI contributions (16.16±5.04%). Unfortunately, this reflects the lack of effectiveness from Unicheck, Turnitin and GPTZero for identifying documents generated in Spanish, through ChatGPT. Likewise, this evidence the ease for generating humanized responses that could replace the critical thinking and creative process in learners, which are commonly practiced when writing argumentative assays [9]

Although the aforementioned scenario might seem negative, AI platforms can be applied for acquiring and supporting current technical and non-technical skills within the industry 5.0 framework, including critical thinking [9].

CONCLUSIONS

Critical thinking and other soft skills are necessary to increase the employability of engineering graduates, and to fulfill the industry demands. In this regard, AI platforms such as ChatGPT are merging with the needs of Industry 5.0, however they are also setting a challenging scenario for the different actors involved in the educational process, especially when providing and assessing soft skills through creative and argumentative activities. One of the challenges is linked with the inefficiency of institutional tools for detecting AI generated products. Because of this panorama, modifications should consider not only the implementation of new learning strategies, but the familiarization of facilitators and learners with applicable AI tools that could enrich the education process and its skills, as well as improve graduate employability.

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Developing the modern construction professional through a continuing education programme at the Centre for Advanced Timber Technology

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CONTEXT

The construction sector uses more raw materials and produces more waste than any other in the UK, and it is responsible for around 40% of the country's carbon emissions. It therefore must transition to more sustainable forms of delivery and create a built environment which operates more efficiently to reach net zero carbon targets by 2050. Organizations such as the Chartered Institute of Building (CIOB) are encouraging a transition in skills for built environment professionals so that they can deliver environmentally sustainable construction while championing diversity, inclusion, and worker welfare.

No longer are the lowest cost / lowest quality forms of delivery acceptable, as exemplified by the UK having 27 million homes requiring retrofitting to achieve modern energy performance standards. Carbon-intensive materials need to be used as a last resort, with low embodied energy materials brought to the fore. A shift towards building with timber is therefore not surprising, since wood stores carbon, has renewable characteristics, and requires minimal energy to transform. Government policy now recognises this, with the UK signing a declaration at COP 28 "advancing policies and approaches that support low carbon construction and increase the use of wood from sustainably managed forests in the built environment." In late 2023, the UK government released a Timber in Construction Roadmap which will also present valuable opportunities for economic growth, rural jobs, and levelling up.

This policy shift will require new workers, and workers with new skills. Given the historic educational emphasis on carbon intensive materials and due to emerging technologies like building information modeling (BIM) and VR/AR, built environment professionals will need continuing education to enact these changes in practice. They also need a more holistic understanding of building performance to ensure healthy, durable assets, as well as a suite of transferable skills in communication, sustainability, and ethics. Finally, due to the rural and decentralised location of this workforce, this continuing education will have to be accessible, flexible, and responsive to accommodate its needs.

KEYWORDS: Construction, Timber, Decarbonisation, Net Zero, Upskilling/Reskilling, Professional Skills, Industry Collaboration

PURPOSE OR GOAL

To enable this much needed educational and construction delivery transition, the Centre for Advanced Timber Technology (CATT) at the New Model Institute of Technology and Engineering (NMITE) in partnership with Edinburgh Napier University has collaborated with industry and other organisations that embrace net-zero approaches such as Timber Development UK and the Passivhaus Trust. This collaboration between industry, academia, and trade organisations has enabled an expanding portfolio of continuing education that exemplifies NMITE's ethos of active and experiential pedagogy, industry-informed real-world challenges, and multidisciplinary team-based learning that reflects the reality of professional practice.

APPROACH

CATT's award-winning Timber Technology Engineering and Design courses, endorsed by the CIOB and Chartered Institute of Architectural Technologists for professional development, were designed to provide knowledge on timber as a construction material, how to specify it sustainably, what engineered and advanced timber technologies are, and how to construct them safely to form assets that will stand the test of time. The Enhanced Retrofit Fabric Improvement Training course funded by Department for Energy Security & Net Zero and Midlands Net Zero Hub aims to upskill building practitioners to install, advise on, and troubleshoot existing and new retrofit projects with an emphasis on a "fabric first" approach that improves the insulation of homes without creating unhealthy buildings. Both courses employ blended learning—a combination of online and in-person sessions—that allow for best practice theory to be coupled with hands-on learning experiences using real-world technologies. The in-person sessions take the form of site visits and workshop experiences held at the £7M Construction Excellence Social Value award-winning Skylon Campus built from advanced timber technologies which also acts as a Living Lab that is measured and monitored by sensors to demonstrate long-term asset durability and whole-life value (embodied and operational energy and carbon). All of CATT's continuing education courses are aligned to the Timber in Construction Skills Action Plan, an industry-agreed framework defining needed technical knowledge, core skills, and cross-disciplinary competencies.

The educational model is being enriched not only by industry engagement but also by live research on the CATT Living Lab building and active research projects funded by Forestry Commission England and Built by Nature that are being undertaken in collaboration with a range of external partners including dRMM Architects, Edinburgh Napier University, Built Environment – Smarter Transformation, EcoSystems Technologies and the University of Edinburgh. This ongoing research aims to determine scalable modern methods of construction and the commercial viability of wood fibre insulation from English Forest resource as well as the whole life value proposition of mass timber forms of construction considering embodied and operational carbon as well as user occupant experience.

To date, nearly 200 learners have participated in CATT's continuing education offerings, and a process to study its impact in the sector has been launched.

ACTUAL OR ANTICIPATED OUTCOMES

Findings from these projects will feed into further educational offerings based around enterprise, stewardship, and leadership that will foster innovation across all areas of the construction sector.

CONCLUSIONS

This paper will provide lessons learned from the development, delivery, and iteration of this continuing education programme that results in modern construction professionals who have the knowledge of new methods, new technologies, and new digital platforms that make them work-ready, multidisciplinary, and able to integrate the principles of circularity for a more sustainable future.

Digital tools and artificial intelligence applied to climate change education to address real problems

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CONTEXT

The escalating climate crisis demands an immediate and concerted response, underscoring the critical need for universities to prioritize and integrate comprehensive climate change (CC) education to empower the next generation of leaders with the knowledge and skills essential to develop sustainable and resilient solutions (Carrillo-Nieves et al. 2024). Climate change presents a multitude of interconnected challenges, including intensified heatwaves, extreme weather events, rising sea levels, biodiversity loss, agricultural disruptions, water scarcity, health risks, economic losses, and social inequalities (OECD, 2021). Addressing these impacts requires immediate and comprehensive action to mitigate and adapt to the changing climate. Moreover, visibility of real problems as rising sea level, extreme local weather events, and alterations of the water cycle and impact in the local economy can engage students to face the global issues from an endemic perspective, which in turn induce to propose mitigation and adaptation actions at national and global levels.

The integration of digital and Artificial Intelligence (AI) tools in CC education in college, with a focus on preparing students for a technology-driven labor market is a current need. These tools provide unique learning experiences that promote understanding of complex problems such as CC and will awaken the interest and participation of new generations (Garlinska et al. 2023). It posits that equipping students with digital competencies, alongside a deep understanding of environmental issues, prepares them for a future that requires both technical skills and sustainability awareness. These include the risk of widening the digital divide, the potential for information overload, and the urge for educators to acquire new technological competencies. Additionally, there is a critical analysis of the balance between technology-driven education and the development of soft skills, which are equally vital in the labor market (Poláková et al. 2023). The challenges associated with digital tools in an educational context, such as lack of focus, ethical considerations, over reliance on technology and AI without critical thinking, and attitude facing new knowledge and new ways of learning, were considered.

KEYWORDS: Climate Change Education, Artificial Intelligence, Digital Tools, Fake News, Escape Room

PURPOSE OR GOAL

The motivation behind our study lies in addressing the pressing issue of climate change through education. We aim to utilize technology as a tool to enhance understanding and engagement among students from diverse academic backgrounds. Our research seeks to explore how technology can be effectively leveraged to promote awareness, comprehension, and action on climate change among students pursuing various careers.

APPROACH

In this study we apply effective pedagogical strategies that utilize digital tools to prepare students for the demands of a technology-centric future while promoting engagement in environmental awareness and responsible action regardless of the student major. The strategic incorporation of digital tools in CC education such as Escape CC, an app specially designed for Novus program from Tecnologico de Monterrey; Climate Change Assistant, Cop 28 insights, and Data Eco Analyst. These last three apps are AI-based fed with information available and validated in the network. All the digital tools and AI apps contributed to promoting both interest in learning and facilitating the understanding of CC, allowing them to identify viable solutions to face what will undoubtedly be one of the main problems that humanity is facing.

In brief, Escape CC consisted in a series of activities of both summative and formative assessment oriented to promote an environment of healthy competition. Every student was a part of a national delegation from state members of the UN (United Nations). This awakened the motivation in students and contributed to the understanding of the technical complexity of climate change. The final call for students was to internalize the importance of adjusting behaviors and actions aimed to promote mitigation and adaptation strategies to climate change from a country perspective.
The Climate Change Assistant, powered by the ChatGPT model, as well as the AI-based digital tools on CC, aims to simplify the understanding of climate science concepts. Utilizing natural language processing, it delivers information on climate science topics in an accessible manner. This tool serves as an educational resource for individuals looking to comprehend global climate change, its impacts, mitigation methods, and adaptation strategies. It not only condenses existing climate science knowledge but also ensures the content is easily understandable, fostering broader education and awareness. Additionally, the Assistant prompts discussions on several topics such as IPCC (Intergovernmental Panel on Climate Change) findings, reducing carbon footprints, the greenhouse effect, and renewable energy sources. Users can engage in conversations with the Assistant to gain informative and easily comprehensible insights into the science of climate change.
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ACTUAL OR ANTICIPATED OUTCOMES

The experience of applying Escape CC to promote participation and learning in intensive courses of 5 and 15 weeks (about 3 and a half months) highlighted the importance of addressing climate change education in a comprehensive manner, including ethical, humanistic, and interdisciplinary aspects. Furthermore, the influence of cultural, geographic, and socioeconomic factors on students' perceptions of climate change underlined the importance of adapting educational strategies to regional concerns and misconceptions. Universities play a pivotal role in nurturing the "climate change generation", equipping them with the knowledge and motivation necessary to contribute meaningfully to climate action and policymaking. Therefore, climate change education must go beyond the transmission of facts, empowering students with critical thinking skills, a global perspective, and a sense of agency to address climate challenges.

Four “fake news” were generated using AI, each depicting scenarios aimed at discrediting the reality of CC. These notes contended that climate change is not occurring, “that human activities are not to blame,” “that climate change does not pose a significant threat,” and “that addressing climate change is too complex to undertake.” Following the reading of these brief notes, students engaged in a discussion forum where they were tasked with crafting scientifically backed statements to refute the claims made in the posts. Through these exercises, students honed their critical thinking skills, examined evidence-based research, and developed a deeper understanding of

the complexities surrounding climate change and its implications. The forum served as a platform for fostering collaborative learning, encouraging students to challenge misinformation, and promoting informed discourse on one of the most pressing global challenges of out of time. Students engaged in immersive role-playing scenarios, fostering collaboration, critical thinking, and effective communication skills. Through this interactive experience, participants developed soft skills such as problem-solving, adaptability, and teamwork, vital for navigating complex real-world challenges.
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CONCLUSIONS

The urgent nature of CC needs a comprehensive approach to provide higher education with dynamism and a quick speed. Integrating digital tools and Artificial Intelligence (AI) into climate change education is vital for preparing students for a technology-oriented future. These tools offer unique learning experiences that promote understanding of complex problems and engage new generations. However, challenges such as the digital divide and over-reliance on technology must be addressed. Effective pedagogical strategies that incorporate digital tools, such as Escape CC and Climate Change Assistant, have been successful in promoting engagement and understanding among

students even from various backgrounds. These tools not only simplify climate science concepts and foster discussions on mitigation and adaptation strategies, but also empower students with the skills necessary to effectively take action on climate change.

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Driving Equality: Advancing Women's Empowerment through Education in the Automotive Industry

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CONTEXT

In the automotive industry, a silent revolution brews, challenging the long-standing norms of a traditionally male-dominated field. A legacy of gender disparity has painted the sector with broad strokes of physical labor and leadership in the hands of men, casting a shadow on women's representation and accessibility to roles of influence (Horak and Cui 2017; Janis and Zulkipli 2020; Eberl and Drews 2022). However, there's a wind of change: concerted efforts reinforce vocational educators' expertise and foster boardroom diversity (Serpil et al. 2018). Initiatives are gaining momentum, focusing on educational attainment and traineeships tailored to encourage female participation and leadership in the sector (Akinsiku and Ajala 2018). These advancements are not just about equality; they represent industry's evolution, acknowledging that inclusivity and diversity drive true innovation and progress.

KEYWORDS: Empowering women, gender equality trends, automotive sector, continuing education, higher education, educational innovation.

PURPOSE

To highlight the benefits of continuing education of women in the automotive sector and the role of policy changes and industry commitments, stressing the importance of research and international cooperation.

APPROACH

Our research examines how educational initiatives help foster gender equality in the automotive industry. We analyze success stories and data to identify factors contributing to empowering women, such as vocational training, mentorship, leadership workshops, and scholarships. Our goal is to provide actionable insights that promote women's full participation and advancement in this traditionally male-dominated field.

OUTCOMES

The automotive industry is transforming to diversify its leadership and workforce. Women are encouraged to join this traditionally male-dominated field, creating opportunities and challenges. The industry recognizes the value of diversity in leadership and aims to bridge the gender gap through targeted educational strategies. This shift triumphs for equality and enhances the industry's competitiveness and innovation potential.

4.1. Empirical Advances in Women's Empowerment

In Canada, the underrepresentation of women in assembly and parts production roles presents an opportunity for transformative growth (FOCAL Initiative 2020). The industry has skilled, untapped female potential, with women participating at less than half the rate of the national labor force in these roles. Diversity and inclusion programs, flexible work arrangements, and defined career progression paths are crucial in unleashing this potential. By doing so, the automotive sector can correct imbalances and drive

forward with a more diverse and dynamic workforce. In embracing gender diversity, the automotive industry is driving toward a future of enhanced corporate resilience and market competitiveness.

4.2. Narratives of Change

Reimagining gender roles, the U.S. automotive industry showcases the transformative power of education and mentorship for women ascending to leadership. These initiatives, highlighted through compelling case studies, catalyze personal growth and professional ascension, mirroring the Capabilities Approach's (CA) ethos. Loots and Walker's (2015) scholarship illustrates CA's influence on gender policy reform—ensuring bodily integrity, dignity, and voice—the change narrative fosters individual triumph and collective social justice.

4.3. Comparative Impact Analysis

Building on the evolving narratives, we scrutinize the transformative effects of educational strategies on women's empowerment. Before targeted educational interventions, the automotive industry's gender dynamics were biased and depicted a male-dominated hierarchy, impeding women's empowerment. However, a paradigm shift occurred, documenting increased involvement and commitment alongside quality enhancements (Roslin et al. 2019; Sharma and Bhati 2017).

4.4. Navigation Persistent barriers

While educational strategies mark progress, entrenched barriers in gender equality persist. Volvo Cars' project work still embodies a carnival masking persistent gender biases (Styhre, Backman, and Börjesson 2005). Their research unveils a dichotomy: vibrant creativity shadowed by unyielding gender stereotypes, with technical and managerial roles often segregated. This veils the structural barriers and masculine norms that impede women's advancement and visibility in the corporate narrative (Balducci, 2023). These findings challenge us to unravel the complex gender-environment-culture interplay that shapes and sometimes constraints.

4.5. Future Directions and Policy Implications

Advances in gender equality in the automotive industry signal progress, but a persistent gender divide calls for innovative educational models (Suyitno et al. 2022). The roadblocks of traditional roles, implicit biases, and enduring stereotypes demand transformative policies. Promoting a cultural shift with men as active allies is crucial for navigating these complex intersections. Pioneering research and recalibrated educational strategies, fueled by legal fortitude and international synergy, are the keystones for realizing the full spectrum of women's empowerment.

CONCLUSIONS

Concluding this exploration, we discern that the automotive sector is crucial. Innovation and diversity must advance together, with continuous education and adaptive training as pivotal drivers for gender equality. The studies presented illuminate the path: When educational strategies and policy interventions target the persistent barriers facing women, the industry becomes more inclusive and reaps the benefits of diversity. Ensuring women's empowerment becomes a cornerstone of automotive progress. The industry must commit to nurturing talent, dismantling obstacles, and breaking stereotypes and biases.

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Empowering Data Analytics Learning: Leveraging Advanced Large Language Models and Visualization Tools

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CONTEXT

The emergence of Large Language Models (LLMs) applications, such as ChatGPT, Bard, Llama, Falcon, Cohere, and others, offer unprecedented opportunities within educational contexts due to their potential as supportive tools for enhancing learning across a range of subjects, notably technical domains within computational sciences. However, LLMs applications effectively into technical education, specifically in data analytics topics, presents significant challenges for students and professionals from non-computational fields, including various branches of engineering. (e.g., sustainable, chemical, industrial, etc.) [1, 5]. Conventional uses of such applications in educational environments tend to prioritize immediate problem-solving tasks, such as generating snippets of code or troubleshooting coding issues, rather than promoting a deeper understanding of data analytics projects or generating refined source code with a unified system perspective. This approach limits the process of learning programming skills, and more importantly, data analytics-related skills [2, 3].

KEYWORDS: ChatGPT, Data Analytics Education, Non-Computational Backgrounds, LIDA, Industry 5.0, GPT-4 API integration, Reskilling and Upskilling.

PURPOSE OR GOAL

This study explores the effectiveness of employing LIDA [4], a novel tool designed for automatically creating grammar-agnostic visualizations and infographics using LLMs alongside the ChatGPT API (GPT-4), to assist students and professionals from non-computational backgrounds in acquiring data analytics skills. Accordingly, we promote moving past the conventional use of LIDA and GPT-4, advocating for their transformation into a valuable tool that supports the complete construction of Data Analytics applications. This implementation holds great promise for substantially enriching the continuous educational experiences and broadening the skillsets of those who engage with it.

APPROACH

We conducted a case study involving a group comprising 30 students and 20 professionals from diverse non-computational backgrounds, including some spanning various engineering disciplines (e.g., sustainable, chemical, industrial, etc.). The study centered on a conventional data analytics project, featuring a dataset well-established in literature. Initially, the traditional data analytics pipeline was presented, followed by the development of the project solution using standard Python packages for data science and analytics, such as scikit-learn, pandas, seaborn, among others, within a collaborative programming environment in the cloud, such as Google Colab.

Subsequently, after completing the project using these tools, participants were tasked with utilizing ChatGPT in a conventional manner to reproduce the same solution. In this approach, ChatGPT served as an external prompt tool, offering code snippets to be integrated into the project as required. Finally, focusing on the transformative nature of our approach, participants were directed to construct a third iteration of the project solution by integrating LIDA with the GPT-4 API. This step aimed to leverage the synergies between LIDA and an LLM, offering a novel approach to data analytics learning.

It is crucial to emphasize that the integration of LIDA with the GPT-4 API facilitates the comprehension and concise summarization of data in natural language. As a result, development with LIDA gains the ability to respond to any prompt originating from the project's source code itself, including inquiries related to the goals of the data analytics project, while also automatically performing tasks such as data summarization and data exploration. Furthermore, LIDA excels at crafting stylish, impactful visualizations, providing meticulous explanations for visualizations derived from both code and charts. Additionally, it enhances visualizations through self-evaluation feedback, adjusts visualizations based on user-provided or compiled feedback, and recommends additional visualizations that could benefit the project [4].

ANTICIPATED OUTCOMES

We conducted both qualitative and quantitative analyses on our case study. The quantitative analysis was based on measuring development time. On average, when participants utilized ChatGPT conventionally experienced a project development speed that was 10% faster than when used traditional tools. Furthermore, when participants utilized LIDA integrated with the GPT-4 API, the data analytics projects were completed within a notably shortened timeframe, resulting in project development being accelerated by up to 30%. For qualitative analysis, surveys were conducted, revealing that over 80% of participants reported that utilizing LIDA and GPT-4 had a significantly more beneficial impact on their data analytics learning process, while over 90% indicated that the development process was notably more efficient and instructional.

The authors of this study also served as instructors and evaluated the quality of the projects developed by the participants. From the instructors' standpoint, projects utilizing LIDA demonstrated enhanced comprehension and application of data analytics concepts among participants, irrespective of their computational background. Integrating LIDA with GPT-4 led to projects of superior quality, indicating a heightened proficiency in data management and application development. Furthermore, the combined use of LIDA and the GPT-4 API elevated the narrative coherence and storytelling of the projects, fostering an immersive and engaging learning atmosphere.

CONCLUSIONS

This study accentuates the potential of leveraging advanced LLMs, extending far beyond their standard functions, to fundamentally transform how students and professionals develop data analytics competencies, even those from non-computational disciplines. Notably, integrating state-of-the-art libraries such as LIDA yields marked improvements in the learning experience. Hence, our case study demonstrated that participants enhanced skills related to accessibility to computational resources, data literacy, programming education, debugging, and interpreting visualizations. Additionally, higher levels of participant satisfaction were achieved, notably emphasizing an enriched learning experience, particularly for such individuals lacking prior programming experience.

Considering the swiftly evolving workforce dynamics shaped by technological progress, our approach mirrors industry trends, igniting a renewed emphasis on professional development and ongoing learning, all in line with the principles of Industry 5.0. Furthermore, with technologies such as LIDA anticipated to gain prominence in the near future, we envision this study as a starting point towards their routine integration into educational settings. As future work, we aim to replicate this experimentation with a larger participant pool, exploring technologies akin to LIDA and potential integrations with LLMs beyond GPT-4.

Finally, our study highlights the pivotal role of utilizing tools such as LIDA and its counterparts in advancing the acquisition of data analytics skills. This not only contributes to our longstanding aspirations of fostering sustainability and inclusivity in engineering education but also empowers lifelong learners to thrive in a dynamic and evolving environment.

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Empowering Industry 5.0 Competencies and Skills: A Case Study in Teaching Automation for Manufacturing Skills

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CONTEXT

In preparation and implementation of Industry 5.0, cultivating future-ready competencies is paramount, particularly in industry contexts. This necessity arises from the objectives of Industry 5.0, which prioritize industrial sustainability and worker well-being (Xu et al. 2021) and the promotion of resilient industries ("Industry 5.0 - European Commission," n.d.). As indicated by the IEEE, the forthcoming transformation of engineering education over the next 100 years will shift its focus from an emphasis on hands-on and practical experience towards fostering engineering science and analytic thinking. This transformation will integrate insights from social behavior science and develop a comprehensive understanding of how information, computation, and communication can be effectively integrated (Froyd, Wankat, and Smith 2012). While Industry 4.0 is appointed to have cyber-physical systems to drive digital transformation across various industrial sectors and integrate information, communication intro, production, and automation (Gürdür Broo, Kaynak, and Sait 2022), industry 5.0 demands a different approach. Here, cyber-physical systems are envisioned to address social problems within virtual scenarios (Klotzer, Weibenborn, and Pflaum 2017). In this context, the present study explores a transformative educational experience aimed at cultivating these essential skills and reducing the retraining or reskilling of the students upon graduation (Gürdür Broo, Kaynak, and Sait 2022) . The case study centers on assembling electronics and mechanical components for a plastic extrusion machine, specifically emphasizing collaborative robotics with humans, integrating leading automation technologies from Industry 4.0 for the class Automation of Manufacturing Systems, and using the Smart Factory lab from Tecnologico de Monterrey. These efforts are validated through virtual simulations aimed at understanding production requirements and human-robot interactions.

KEYWORDS: Industry 5.0, automation, manufacturing systems, manufacturing engineering, cobots, robotics.

PURPOSE OR GOAL

This immersive experience aims to provide students with a thorough understanding of advanced Industry 4.0 technologies, thus preparing them for the challenges of Industry 5.0. Through observation of students' interactions with innovative digital technologies from Industry 4.0 and their engagement with human interaction, ergonomics, and flexibility within a manufacturing cell with collaborative robots, the aim is to underscore principles in Industry 5.0. Furthermore, this experience prompts students to contemplate the future social challenges of the new manufacturing production systems and consider the evolving role of workers in these frameworks.

APPROACH

Through the analytics of this course and immersive experience, students engage in hands-on activities designed to progress their skills and knowledge to navigate Industry 5.0 challenges. Firstly, students were introduced to the foundational aspects of manufacturing production, including cycle times, ergonomics, and production concepts, emphasizing principles like 5s and production optimization. Secondly, students mastered the operation of collaborative robots (cobots), gained proficiency in Human-Machine Interface (HMI) systems and PLC programming, acquired expertise in sensor integration, and explored the options of vision systems. Finally, students integrated their understanding from previous steps to align manufacturing systems with automation, emphasizing the sustainability and well-being of human-cobot interactions(Ivanov 2023). Integral to this educational journey is the virtual design of fixtures, jigs, and poka yokes, all aimed at optimizing and automating the production processes and reviewing concepts as Design for Manufacturing and Assembly (DFMA). This optimization is achieved while focusing on the ergonomic aspects of human-machine collaboration. The validation of automation through Tecnomatix Process Simulate, underscores the practical application and optimization, provides valuable insights into students' perceptions, and facilitates iterative improvements in the educational approach. Overall, this approach ensures that students are not only equipped with technical skills but also gain a holistic understanding of the social and ergonomic implications of all technologies from Industry 4.0 and reorder steps of the manufacturing process to complain the new challenges of the Industry 5.0 objectives.

ACTUAL OR ANTICIPATED OUTCOMES

The immersive experience described in the study yielded several significant outcomes that align with the goals of the challenges of Industry 5.0. Firstly, students obtained a diverse skill set from the most influential factors in engineering education: automation, connectivity, higher education environment, trust in technology, and lifelong learning (Gürdür Broo, Boman, and Törngren 2021). By engaging in hands-on activities and virtual simulations, students develop proficiency in all industry 4.0 technologies. In this case study, all elements in the production process were optimized while focusing on the ergonomic aspects of human-machine collaboration. Figure 1 illustrates the iterative nature of the process, demonstrating students' active engagement in refining manufacturing strategies for the placement of the electronic plastic extrusion machine. By alternating between physical and virtual environments, students validated a strategy for enhancing human interaction with the manufacturing cell of the SMART Factory lab. Thirdly, the pivotal role of Siemens' Process Simulate software in facilitating simulation and validation of robotics integration underscores the practical application of Industry 5.0 principles. These simulations provided invaluable insights into the feasibility and effectiveness of integrating advanced technologies into physical systems and preparing students to navigate real-world industrial settings.

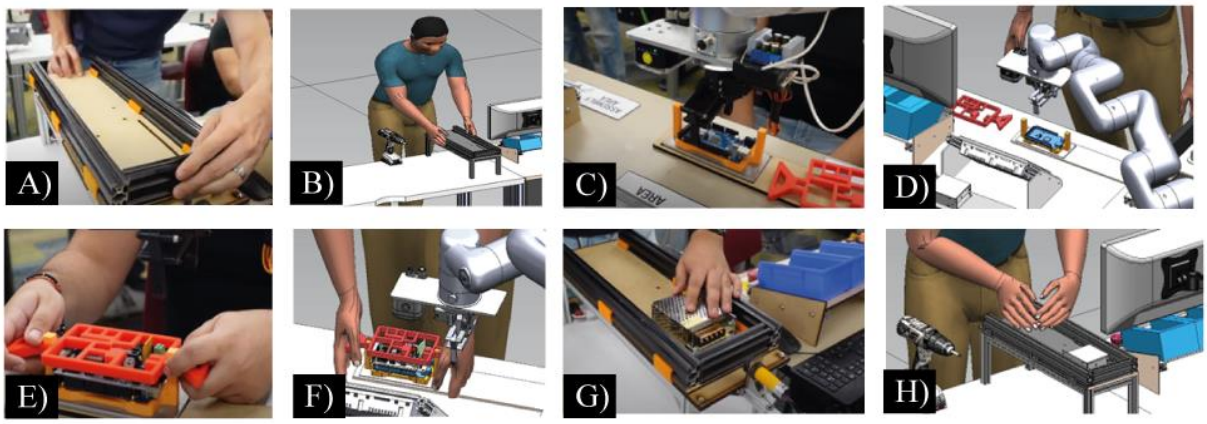

Figure 1. Human interactions and digital twin steps. A) and B) Placement of the machine's base by the worker from the previous assembly. C) and D) robot placed the electronics into the machine. E) and F) the worker validates the assembly using a 3D printed fixture. G) and F) the worker secured the machine's power supply assembly.

CONCLUSIONS

In conclusion, this case study is a compelling example of how educational programs are evolving to impart students with the future-oriented skills demanded by Industry 5.0. By immersing students in a transformative educational experience focused on hands-on learning and virtual simulations, this study effectively imparts future-oriented skills essential for navigating modern industrial environments. The tangible outcomes, as evidenced by the acquisition of diverse skills and the optimization of manufacturing processes, underscore the practical application of the competencies. Moreover, the emphasis on human-centered manufacturing in the educational journey highlights the pivotal role in enhancing competitiveness in an organizational context. This study exemplified the requirements of Industry 5.0 and prepared students to thrive in a more dynamic and proactive educational approach.

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Empowering the Future Workforce: Transformative Technologies and Learning Approaches in Continuing Engineering Education

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CONTEXT

Continuing Engineering Education (CEE) faces various challenges to retain its relevance and sustainability due to rapid technological advances and evolving labor demand (Ustundag et al. 2018; Treviño-Elizondo and García-Reyes 2023). These challenges encompass staying abreast of cutting-edge technologies and adapting to the changing landscape of workforce requirements. In the face of such complexity, traditional pedagogical methods often face the challenge of keeping pace with the rapid evolution of Industry 4.0 technologies and meeting the dynamic needs of engineering professionals (Hernández-Muñoz et al. 2019; Chakrabarti et al. 2021; Caratozzolo et al. 2023). These methods often fail to provide the agility and depth of expertise that contemporary engineering practices demand.

KEYWORDS: Industry 4.0; Higher Education; Lifelong Learning; Virtual Reality; Artificial Intelligence.

PURPOSE OR GOAL

Within this work, we seek to address the challenges of the CEE and try to maintain its sustainability by proposing solutions through the new transformative technologies of Industry 4.0 in conjunction with the best practices in Higher Education (HE). The research question focuses on how the integration of new technologies, such as artificial intelligence and virtual/augmented reality, into educational frameworks, along with innovative learning approaches, could empower the future engineering workforce, closing gaps in skills, combating technological obsolescence, and promoting a culture of continuous learning among engineering professionals.

APPROACH

The methodological process for this work involves exploring the intersection between new Industry 4.0 technologies and current higher education pedagogical strategies in search of designing a framework for CEE programs that are at the forefront and prepared for the future. Data and evidence are collected through an exhaustive review of the literature (Motyl et al. 2017; Hernandez-de-Menendez et al. 2020), in-depth analysis of pertinent case studies (Schuster et al. 2016; Valeyeva et al. 2019; Miranda et al. 2021), and consultations with domain experts. Through the analysis, we seek to identify critical challenges in CEE, evaluate the effectiveness of integrating new technologies and innovative learning approaches, and propose a holistic strategy to address the identified problems.

ACTUAL OR ANTICIPATED OUTCOMES

Among the expected results, we can mention the development of a platform and a taxonomy of skills driven by natural language processing tools, seeking to demonstrate the potential of fusing the technical advances of Industry 4.0 and higher education pedagogical strategies. The study also plans to highlight the effectiveness of online courses, virtual laboratories, collaborative platforms, and projects aligned with the industry, seeking to close the theoretical-practical gap and try to satisfy the dynamic needs of Industry 4.0. In addition, an attempt will be made to highlight the importance of the principles of Education 4.0 in the configuration of future CEE programs.

CONCLUSIONS

Based on the evidence presented, the study seeks to conclude that integrating new technologies and innovative learning approaches can be essential to empower the future engineering workforce through CEE programs. It should be emphasized that educational pathways that are flexible, accessible, and interactive could be critical, as well as creating industry-aligned projects and student-centered technology-driven methodologies to ensure the relevance and sustainability of CEE in the era of Industry 4.0.

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Enhancing Future Skills with Competency-Based Engineering (Continuous) Education

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CONTEXT

In a rapidly evolving world and professions requiring higher proficiency levels, a traditional educational model based solely on the passage of knowledge is not enough. Besides technical knowledge and skills, graduates from every field require abilities that transcend beyond their discipline (Hansen and Brogaard Bertel 2023).

With this purpose in mind, in 2019, Tecnologico de Monterrey (Tec) launched the educational model Tec21 (MET) to develop graduate students with a profile of disciplinary and transversal competencies (Olivares Olivares et al. 2021, 23). Competencies consciously integrate knowledge, abilities, attitudes, and values to overcome structured and uncertain situations. Disciplinary competencies involve the knowledge necessary for professional development, while transversal competencies encompass the skills developed for every graduate program (Instituto Tecnológico y de Estudios Superiores de Monterrey 2016). The seven transversal competencies include (1) self-knowledge and management, (2) innovative entrepreneurship, (3) social intelligence, (4) ethical and civic engagement, (5) reasoning for complexity, (6) communication, and (7) digital transformation (Tapia Gardner 2021).

An internationalization experience can provide a new learning environment to contribute to students' education. Students can observe their strengths, developed skills, and growth areas while navigating unfamiliar circumstances. In this research, participants generated a personal analysis while studying abroad, providing insight into the competencies they developed during three years in their educational model.

KEYWORDS: Higher education, educational innovation, studying abroad, transversal competencies, future skills, challenge-based education

PURPOSE OR GOAL

This research aims to understand how students perceived their academic and personal growth, contrasting their experiences at their home institution and the international university. The purpose is to analyze how a challenge-based model prepares graduate students with competencies that align with the new demands of their professions in a rapidly evolving field. This type of educational model can be tailored for continuing education, providing engineering professionals with problem-solving skills for the demands of the 21st century.

APPROACH

Data was collected through remote semi-structured interviews conducted via video conference. Participants were thirteen seventh-semester Mexican engineering students studying abroad during the 2021-2022 academic year. These students spent one academic semester in Europe and two Latin American countries, with the majority enrolled in public universities, while only two attended private institutions.

During the interviews, participants responded to 43 questions tailored to assess their progress in the seven transversal competencies, their performance, and their perceptions of the MET during their study abroad experience. These questions were classified into different categories with a particular focus. Each competency had dedicated questions aimed at gauging its impact on students. Additionally, general questions were assigned to specific competencies based on how the answers provided insight on particular topics.

ACTUAL OR ANTICIPATED OUTCOMES

The development of transversal competencies has focused on giving students of every field the tools to develop and adapt in a constantly changing world. The results revealed that the competencies that participants developed most prominently were complexity reasoning, social intelligence, and communication.

Regarding reasoning for complexity, students expressed that the challenge-based educational approach in the MET enabled them to visualize theoretical concepts in action through real-life problems. This connection to subjects covered in class extended their understanding beyond the confines of the classroom, fostering the capacity to apply these concepts creatively in the pursuit of innovative solutions.

Focusing on social intelligence, five students mentioned ineffective teamwork experiences with their international classmates. They described how some of their classmates had an individualistic attitude that affected collaboration. Student 3 commented, “As they are very closed-off and not used to working in teams when I arrived from Tec21, where all my work was in teamwork, it was very easy for me to work with them because there are things that I know I can help them with, and it facilitates our work.”

Regarding communication competency, five students noted that they could articulate their ideas and projects more effectively during class presentations than their peers. Student 10 elaborated, “Tec has equipped me with a greater ability to relate and expose my ideas regarding projects because here, individuals often lack the confidence to speak publicly.”

Regarding self-knowledge and management, five students showed that, due to the MET’s five-week challenge-based courses, they were used to working in short periods and delivering high-quality assignments. However, eight students reported higher stress levels at Tec; six of the former mentioned that their primary reason for higher stress levels was high workloads. When discussing self-knowledge, the students’ responses acknowledge having developed it further on their experience abroad; living alone forced them to learn to overcome the challenges of being autonomous.

Innovative entrepreneurship provided varying results. Five students mentioned they saw themselves as more proactive and innovative than their classmates. However, three mentioned having lower innovation abilities depending on the subject or seeing isolated cases of greater entrepreneurship skills.

For ethical and civic engagement, it is important to highlight that during their international experiences, students did not participate in activities that allowed them to showcase their development in this competency. On the other hand, only one question was addressed for digital transformation, yielding limited valuable insights for the study.

CONCLUSIONS

Learning does not end in a classroom. It is a lifelong activity that reaches out into different models beyond the academic years (Akçay and Yıldırım 2014). Educational models need to adapt to a world with knowledge that is being updated constantly. Results suggest that challenge-based learning has been effective for students in developing reasoning for complexity to solve real-world problems while allowing them to communicate their ideas effectively. Social intelligence is a skill required in every aspect of life, and results show that students can develop it in teamwork. While ethical and civic engagement was not significantly observed, fostering activities that promote citizenship is important. Continuing education can benefit from challenge-based learning, as these skills are needed beyond a college degree, providing experience that enhances competencies for 21st-century challenges.

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Enhancing Professional Development: The Role of Professional Master's Programs in Continuing Education

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CONTEXT

In an era marked by rapid technological advancements and shifting industry paradigms, the professional landscape is undergoing a significant transformation, necessitating an ever-evolving skill set among professionals. Within this context, the relevance of continuous education and skill enhancement cannot be overstated, particularly in the dynamic fields of engineering and sciences. Historically, there has been a discernible gap between the conventional curricula of academic institutions and the practical, real-world requirements of the professional sector. This gap underscores a critical need for educational programs that not only align with current industry demands but also anticipate future trends. "Enhancing Professional Development: The Role of Professional Master's Programs in Continuing Education" addresses this need by exploring the integral role of professional master's programs in the continuous development of professionals. Drawing upon a blend of qualitative and quantitative research methodologies and leveraging data from diverse programs, with a notable emphasis on the innovative approaches adopted by programs that offer flexibility, alternative certifications, and industry collaborations, this study assesses how these advanced educational endeavors contribute to broadening the professional skill sets and ensuring workforce readiness. The findings highlight the programs' multifaceted learning outcomes, such as staying updated with the latest technological innovations, fostering critical thinking and problem-solving capabilities, and nurturing interdisciplinary knowledge—all essential for navigating complex, real-world challenges. Furthermore, the study emphasizes how these programs incorporate significant flexibility, allowing professionals to tailor their learning experiences to fit their specific career goals while maintaining their professional commitments. This flexibility often includes opportunities for obtaining additional certifications and credentials that enhance employability and professional stature. Moreover, the collaboration with renowned institutions and the integration of specialized bootcamps enrich the educational experience, providing students with access to cutting-edge resources, expert faculty, and global networks. These partnerships not only augment the learning landscape but also foster a culture of lifelong learning, an increasingly valued trait in today's workforce. Conclusively, the article posits that professional master's programs serve as a crucial bridge between academic advancement and practical professional excellence, thereby equipping professionals with the requisite skills and knowledge to thrive in their careers. By doing so, these programs contribute significantly to shaping a competent, innovative, and adaptive workforce poised to meet the modern professional landscape's challenges. The ongoing success and evolution of these programs affirm their pivotal role in professional development and underscore their importance in a continuously evolving educational and professional ecosystem.

KEYWORDS: Professional Development, Continuous Education, Master's Programs, Workforce Readiness, Skill Enhancement, Interdisciplinary Knowledge, Lifelong Learning.

PURPOSE OR GOAL

The primary purpose of this study is to explore the impact and efficacy of professional master's programs in effectively bridging the gap between traditional academic education and the rapidly evolving demands of today's professional sectors, particularly in the fields of engineering and sciences. Motivated by rapid technological advancements and consequent shifts in industry needs, this research aims to dissect how these advanced educational programs contribute to professional growth, skill diversification, and overall readiness of individuals for a dynamic workforce. The research is driven by the hypothesis that professional master's programs, with their emphasis on practical, real-world applications and an ethos of continuous learning, are crucial in equipping professionals with the essential skills and knowledge needed to excel in their careers. This hypothesis is rooted in the observation that traditional academic offerings often do not fully meet the practical demands of the professional world, thus creating a need for an educational approach more closely aligned with the current and anticipated needs of the industry. Furthermore, this study aims to clarify how these programs not only adapt to changes but also proactively anticipate future shifts in professional requirements. By incorporating elements such as flexible course delivery, opportunities for gaining industry-recognized certifications, and collaborations with leading organizations and experts, professional master's programs offer a robust platform for continuous professional development. Additionally, the study seeks to illustrate the role of these programs in fostering a culture of lifelong learning and innovation. By doing so, they contribute significantly to the development of a competent, adaptable, and forward-thinking workforce. This workforce is not only capable of navigating the complexities of the modern professional landscape but also poised to lead and influence future industry trends. The ultimate goal of this study is to provide comprehensive insights into how these educational initiatives can effectively mold professionals who are not only ready to meet today's challenges but are also equipped to drive tomorrow's innovations. By elucidating these dynamics, the research aims to underscore the transformative potential of professional master's programs in redefining traditional education paradigms and in enhancing the strategic capabilities of the workforce across various sectors. In doing so, it seeks to affirm the essential role of these programs in fostering an environment where continuous learning and proactive adaptation become the mainstays of professional development.

APPROACH

To meet the growing demands of the global economy and ensure the professional development of our students, the School of Engineering and Sciences of Tecnologico de Monterrey has meticulously developed seven specialized professional master's programs. These programs are strategically designed to enhance the competencies of today's workforce and prepare graduates for leadership roles in their respective fields. The programs offered include:

- Master in Engineering Management: This program equips future leaders with the necessary skills to manage complex engineering projects, foster innovation, and drive efficiency in operations. It merges technical expertise with management strategies, ideal for professionals aiming to lead engineering teams.

- Master in Applied Artificial Intelligence: As artificial intelligence transforms industries, this program offers a deep dive into practical applications of AI. Students learn to develop AI-driven technologies and apply these innovations to solve real-world problems across various sectors.

- Master in Cybersecurity: This critical program is designed to address the increasing threats in cyber spaces. It provides comprehensive knowledge in network security, data protection, and threat mitigation, preparing students to safeguard digital infrastructures.

- Master in Innovation for Business Development: Focusing on the creation and implementation of innovative strategies to foster business growth, this program helps aspiring entrepreneurs and business leaders to develop transformative ideas that disrupt markets and create value.

- Master in Information Technology Management: Bridging the gap between complex information technologies and business management, this program trains professionals to oversee IT resources effectively, align IT strategies with business goals, and enhance organizational performance.

- Master in Energy Management and Renewable Sources: This program addresses the urgent need for sustainable energy solutions. It offers students insights into managing energy resources, optimizing renewable energy projects, and leading the transition towards sustainable practices.

- Master in Engineering with a Specialty in Quality and Productivity: Designed for professionals tasked with improving industrial processes, this program focuses on quality assurance, process optimization, and productivity enhancement techniques.

The main focus of our approach is to emphasize the flexibility of these programs. Each course is carefully crafted to not only provide foundational and advanced knowledge but also to award an additional certification or credential. This dual benefit enriches the educational experience, broadens professional qualifications, and increases employability in competitive job markets.

ACTUAL OR ANTICIPATED OUTCOMES

The outcomes of this study aim to provide a detailed understanding of the contributions of professional master's programs to the ongoing development of professionals, especially in the realms of engineering and sciences. We expect to highlight several key outcomes, including:

- The provision of up-to-date knowledge and skills that are closely aligned with current industry demands, thereby enhancing the competitiveness and innovative capacity of professionals.

- The enhancement of critical thinking and problem-solving abilities, along with the development of interdisciplinary knowledge, which are crucial for tackling complex challenges in the professional sphere.

- The promotion of a culture of lifelong learning, increasingly valued in today's rapidly evolving workforce.

Additionally, the study is poised to offer insights into how these programs effectively bridge the gap between traditional academic education and practical professional requirements, ensuring that graduates are well-prepared to excel in a dynamic professional environment. The findings are expected to support the hypothesis that professional master's programs are essential for preparing a competent, innovative, and adaptable workforce ready to address the challenges of the contemporary professional landscape.

CONCLUSIONS

The conclusions drawn from this study underscore the critical role of professional master's programs in equipping professionals with the essential skills and knowledge required to navigate and excel in the rapidly evolving professional landscape, particularly within the fields of engineering and sciences. These programs serve as vital bridges between traditional academic education and the practical demands of today's workforce, offering curricula that are both relevant and forward-looking. The key outcomes of the study highlight the success of these programs in fostering critical thinking, problem-solving abilities, and interdisciplinary knowledge. Moreover, they emphasize the importance of promoting a culture of lifelong learning. As a result, graduates of these programs emerge as competent, innovative, and adaptable professionals, well-equipped to contribute to and lead in their respective fields. This research reaffirms the significance of continuous education and skill enhancement in professional development. It strongly suggests that professional master's programs are indispensable for creating a dynamic and capable workforce equipped to meet both current and future challenges, thereby ensuring ongoing professional and industry advancement.

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Exploring Industry 5.0 Skills: a Comprehensive Taxonomy for IT Job Classification

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CONTEXT

The Information Technology (IT) sector, pivotal in shaping Industry 4.0 and transitioning into Industry 5.0, remains robust amidst global challenges such as the COVID-19 pandemic and talent shortages [1]. Given the dominance of IT roles in the global job market [3], the need for a unified framework that accurately identifies and categorizes IT skills has never been more critical. While the International Labour Organization (ILO) has introduced the International Standard Classification of Occupations (ISCO) for job classification worldwide [4], it lacks the granularity required for the IT sector. Previous attempts to address this issue [2] have revealed a gap in alignment with the latest version of ISCO. In this paper, we introduce a novel hierarchical taxonomy designed to support the classification of IT jobs within the ISCO-08 framework.

KEYWORDS: IT employment taxonomy, Industry 5.0 skills, ISCO-08 framework, Workforce demand Forecasting, Lifelong learning, Skill-based job classification.

PURPOSE

This research aims to address this gap by proposing a novel hierarchical taxonomy for IT job classification within the ISCO-08 framework. Our objective is to define IT roles into detailed job categories and subcategories that closely correspond to the evolving demands of the job market. The level of detail in our taxonomy serves as a valuable tool for HR professionals and other stakeholders in the industry, facilitating the accurate classification of the IT workforce. Additionally, it empowers educational systems to prepare individuals with the necessary skills for future roles, fostering a culture of continuing education and lifelong learning essential for adapting to Industry 5.0.

APPROACH

This research aims to address this gap by proposing a novel hierarchical taxonomy for IT job classification within the ISCO-08 framework. Our objective is to define IT roles into detailed job categories and subcategories that closely correspond to the evolving demands of the job market. The level of detail in our taxonomy serves as a valuable tool for HR professionals and other stakeholders in the industry, facilitating the accurate classification of the IT workforce. Additionally, it empowers educational systems to prepare individuals with the necessary skills for future roles, fostering a culture of continuing education and lifelong learning essential for adapting to Industry 5.0.

ACTUAL OUTCOMES

We introduce a comprehensive IT employment taxonomy consisting of 5 major groups (MG), further subdivided into 12 sub-major (SM) categories and 34 unit groups (UG) as follows.

MG1 DATA: Tasked with collecting, analyzing, interpreting, and managing data to assist organizations in making informed decisions. It has 3 sub-major groups:

SM1 CORE: Formed by:

UG1 ANALYSIS: Interprets data, analyzes trends, and provides insights for informed decision-making.

UG2 BUSINESS: Analyzes complex data, develops insights, and offer strategic recommendations focusing on business processes.

UG3 DATABASES: Manages and optimizes databases for efficiency, security, and reliability. Handle data security, backup, and recovery processes.

UG4 ARCHITECTURE: Oversees AI models' integration to ensure the system's scalability and performance.

UG5 GOVERNANCE: Establishes and enforces data policies, ensures data quality and compliance with regulations.

SM2 SCIENCE: Formed by:

UG6 FLAT DATA: Utilizes statistical analysis and machine learning to extract insights from data.

UG7 NETWORK DATA: Analyzes and interprets relational data, applying tools and techniques from complex network and graph theory.

SM3 ENGINEERING: Formed by:

UG8 DATA: Designs, builds, and maintains scalable data pipelines to collect, process, and store large volumes of data efficiently.

UG9 BIG DATA: Specializes in managing and processing large and complex datasets typically found in big data environments.

MG2 SYSTEM: Responsible for maintaining the functionality, quality, and safe functioning of computer systems: It has 2 sub-major groups:

SM4 CORE: Formed by:

UG10 SYSTEM ANALYSIS: Analyzes and designs IT systems to meet business needs, ensuring functionality and efficiency.

UG11 INFORMATION SECURITY: Implements and maintains security measures to protect information assets from unauthorized access or breaches.

UG12 SUPPORT: Provides technical assistance and troubleshooting to users, ensuring smooth operation of IT systems.

UG13 IT GOVERNANCE: Ensures IT aligns with business objectives, complies with regulations, and mitigates risks.

SM5 TEST & QUALITY: Formed by:

UG14 SOFTWARE TEST: Develops and executes test scripts and frameworks to ensure software requirements.

UG15 QUALITY ASSURANCE: Oversees overall quality processes by guiding teams to enhance quality throughout the development process.

MG3 DEVELOPMENT: Responsible for building a computer system. It has 3 sub-major groups:

SM6 SOFTWARE: Formed by:

UG16 DESKTOP: Develops applications tailored for use on desktop computers, ensuring compatibility and functionality across various operating systems.

UG17 MOBILE: Develops and optimizes mobile applications catering to diverse platforms running on portable devices.

UG18 WEB: Develops and maintains websites and web applications, focusing on user experience, functionality, and accessibility.

UG19 RPA: Crafts and deploys robotic based solutions to automate tasks, streamline workflows, and enhance efficiency.

UG20 GAMES: Designs, develops, and optimizes video games for different platforms, blending art, storytelling, and technology.

SM7 ARTIFICIAL INTELLIGENCE: Formed by:

UG21 RESEARCH: Develops innovative algorithms, models, and techniques to tackle complex problems and create intelligent systems.

UG22 ENGINEERING: Designs, develops, and deploys systems based on AI models.

SM8 OPERATION: Formed by:

UG23 DEVOPS: Streamlines software development and operations through collaboration and automation.

UG24 RELIABILITY: Ensures system reliability and scalability via automation and monitoring for large-scale systems.

UG25 AIOPS: Uses Artificial Intelligence techniques to enhance and automate IT operations tasks.

SM9 DESIGN: Formed by:

UG26 UI: Creates visually captivating and intuitive user interfaces.

UG27 Ux: Creates seamless and satisfy user experiences to meet user needs and optimize product usability and accessibility.

UG28 XA: Designs the overall customer journey and interactions through experience architecture.

MG4 INFRASTRUCTURE: Tasked related to the configuration, management, and maintenance of infrastructure for computer systems. It has 2 sub-major groups:

SM10 COMMUNICATION: Formed by:

UG29 LOCAL: Designs, implements, and manages traditional local network infrastructure.

UG30 CLOUD: Manages and maintains cloud-based infrastructure and services.

SM11 ARCHITECTURE: Formed by:

UG31 IT: Designs and oversees the structure of IT systems to meet business objectives, ensuring scalability, security, and integration.

UG32 CLOUD: Designs and implements cloud-based solutions, optimizing performance, cost, and security for scalability and flexibility.

MG5 MANAGEMENT: Guides and oversees IT initiatives, aligning technology with business objectives. It has only 1 sub-major group:

SM12 CORE: Formed by:

UG33 PROJECT SIDE: Works closely with the development team during sprints to clarify requirements, provide feedback, and ensure deliverables meet expectations.

UG34 CLIENT SIDE: Works closely with stakeholders to prioritize features and ensure alignment with business goals.

CONCLUSIONS

The proposed IT employment taxonomy represents a significant advancement in job classification methodology, specifically tailored to address the complexities of the IT sector within the overarching framework of industry 5.0. This tool underscores the critical importance of skill-based job classification in navigating workforce trends and facilitating targeted reskilling and upskilling initiatives for the next generation of IT professionals.

ACKNOWLEDGMENT

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Find a Niche Where Sports, Law, and Data Analytics Intersect

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CONTEXT

The sports industry is increasingly relying on data analytics for more effective deployment of resources and assessment of performance in areas ranging from player productivity to fan engagement, talent identification and development, coaching, sponsorship, and marketing. How the University at Buffalo (UB) is positioned to respond to the increased demand for qualified data analytic professionals by providing an opportunity for professional athletes to transition from the athlete to other managerial roles in the sports industry is explored. Professional development offerings on Coursera have resulted in significant increase in enrollments and higher completion rates.

KEYWORDS: Data Analytics, Sports, Upskilling, Self-paced, Evidence-based Micro-credential, Certificate Program, Law, Engineering

PURPOSE OR GOAL

Sports analytics has experienced significant growth in recent years, and as a result, there is growing demand for professionals with expertise in this field. The increased adoption of data-driven decision-making in sports organizations at all levels has created a wide range of employment opportunities for individuals interested in sports analytics. Our goal was to provide a mini program in data analytics and team management for non-traditional students and former professional athletes where they can expand their knowledge to optimize team operations and transform decisions typical for team managers, scouts, coaches, agents, and facility management professionals.

APPROACH

Having an industry partner in the Professional Hockey Players Association (PHPA) share the importance of delivering short, attainable, credentials, the University at Buffalo developed flexible, non-traditional degree learning opportunities for the PHPA membership that focus on how law and regulations intersect with data analytics and sports management techniques for best practices in the sports industry. We developed curriculum to meet UB's higher education standards and rigor by establishing stackable, one-credit micro-credentials in engineering tied to evidence-based projects learners customized. In the first mini course, students self-reflect and determine a pathway to a future state. By providing content and reflection aligned with industry-relevant positions throughout the courses, the non-traditional professional learners were provided the opportunity to recognize education and skills gaps on which they could focus in the future. Each of the remaining courses built upon the introductory course and provided additional junctures where students choose personalized future directions. Recognizing the common traits of our partner's membership, we established the content for busy, working professionals and enabled self-paced, stackable, modular content resulting in credit and learner-centered digital credentials upon completion.

ACTUAL OR ANTICIPATED OUTCOMES

We vetted the program through the School of Engineering and Applied Sciences department and subsequently at the University level by the Associate Dean's Graduate Council which represents each decanal unit across campus who approved the graduate curriculum and micro-credentials. Our pilot offerings resulted in 20 individuals eligible for one credit and digital credential and three (3) individuals eligible for multiple credits and credentials by completing multiple courses. The courses were offered on Blackboard. Enrollments were cumbersome to those unfamiliar with the university's admission and payment processes that require removing holds, etc. for non-traditional students. The process to get participants

enrolled in the courses once admissions requirements were met included time-consuming, manual administrative steps. We allowed one year for the estimated, self-paced, five weeks of study for those dedicating 2.5 hours weekly for course completion. After five offerings in 2021 and 2022, we moved the offerings to the global platform Coursera and created a pathway to receive credit at UB after receiving a verified Coursera certificate upon course completion. As of early May 2024, we have 839 three-course series enrolled with 24 completers and 52/318, 312/2160, and 37/928 completers/enrolled of courses 1, 2, & 3 respectively on Coursera. The course star ratings are 5, 4.9, and 5 (out of 5) respectively. We anticipate the sports law and data analytics offerings to continue to position engineers and others interested in adopting data-driven-decision making in sports organizations at any level with the skills and knowledge to find their niche in the sports industry.

STAKEHOLDERS AND PANELISTS

Amy Moore, the Program Director will present the teams' approach and findings during IACEE 2024 19th World Conference on Continuing Engineering Education. Moore will begin by introducing the stakeholders that follow. In prerecorded messages, you will hear a compelling argument for the program from Steve Carney, Coordinator, Career Enhancement Program (CEP) of the Professional Hockey Players' Association (PHPA); how data analytics were entwined with legal and sports topics by E. Bruce Pitman, Professor and Computational Data Scientist, University at Buffalo; how continuing education plays a role in transitioning pro athletes into the sports industry roles by Gerry Meehan, Former NHL Player, Team Counsel and General Manager; and the courses value described by Vincent LoVerde IV, former professional athlete, student, and current wealth advisor in Chicago, IL.

CONCLUSIONS

As opposed to the cumbersome, university-based, for-credit program offerings resulting in fewer than twenty-five completers, the comparable professional development offerings focused on bringing sports, data, and analytics together on Coursera have resulted in a significant increase in enrollments and verified certificates upon completion. Thus, in addition to the open, public offerings and possible expansion of an engineering certificate program, we are in the process of creating a private cohort for the PHPA membership on Coursera, as requested by their education coordinator who recognizes the value of continuing and professional development opportunities for their members. Sports organizations, including professional teams, leagues, and collegiate sports programs, are actively seeking skilled sports analysts to gain a competitive advantage and improve overall performance. As the field of sports analytics continues to evolve, the demand for qualified professionals is expected to remain high, providing ample opportunities for those interested in pursuing a career in this exciting and growing field, and University at Buffalo is well-positioned to prepare the workforce and welcomes global expansion.

Fostering Lifelong Learning and Employability Through Capstone Project in Engineering Education

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CONTEXT

In the ever-evolving landscape of engineering, Core Tools competencies hold immense importance, particularly within the realm of automotive manufacturing. While traditionally regarded for their technical applications, this study explores how Core Tools training extends beyond mere technical proficiency, delving into its pedagogical dimensions. By focusing on the educational aspects of Manufacturing Quality Competencies (Core Tools), this research aims to elucidate how such training can empower students with competencies and skills crucial for their lifelong learning journey and seamless integration into the labour market.

KEYWORDS:

Core Tools competencies

Manufacturing Quality competencies

Employability

Lifelong learning culture

Collaboration with industry

Engineering education

Challenge-Based Learning (CBL)

Capstone Project.

PURPOSE OR GOAL

The objective of this study is to investigate a novel educational methodology focused on training prospective engineers in the application of manufacturing quality tools rooted in Core Tools principles. This method involves the execution of a hands-on nine-week capstone project aimed at furnishing recently graduated engineers with the essential skills demanded by the local industry. Customized to meet the precise requirements expressed by the collaborating firm, the project endeavors to narrow the divide between academic instruction and industrial necessities. By undertaking this initiative, our goal is to ensure that engineering graduates are adequately equipped to thrive in their professional capacities upon commencement of their careers.

APPROACH

This study employs an educational approach that integrates practical Challenge-based Learning (CBL) principles into the senior mechanical engineering curriculum. The objective is to bolster students' practical skills and industry acumen in readiness for professional engineering roles. Central to this approach is a nine-week capstone project focused on conceptualizing and crafting a mass-production proposal tailored to a specific product. Serving as the culmination of students' academic journey, this capstone project furnishes them with hands-on experience in tackling real-world engineering hurdles.

A pivotal aspect of this approach is the direct involvement of students with a real-world client throughout the project's lifecycle. From initial kick-off meetings to ongoing communication, students interact with the client to grasp project requirements, constraints, and expectations. This engagement not only immerses students in authentic engineering scenarios but also cultivates vital communication, negotiation, and client-facing skills.

The capstone project unfolds through multiple phases, each aimed at nurturing different facets of students' learning and professional growth. Initially, students analyze technical drawings and engage in client presentations to gain a comprehensive understanding of client needs. Subsequently, students propose manufacturing processes aligned with client requirements, emphasizing feasibility, cost-effectiveness, and adherence to industry standards.

To ensure efficient project management, students utilize industry-standard tools such as the Project Charter and Gantt Chart. These tools facilitate systematic planning, monitoring, and tracking of project progress, thereby enhancing their organizational and project coordination skills. Additionally, theoretical sessions on Manufacturing Quality Tools are seamlessly integrated into the project curriculum to acquaint students with essential techniques employed in industry for documentation generation and quality assurance.

The Challenge Framework

The challenge spans 12 weeks, during which students receive five hours of direct instruction from teachers every weekday. Teachers cover five general topics or modules:

1. Project Management
2. Design Methodologies (Advanced techniques for project evaluation and selection)
3. Verification and Detailed Design
4. Electromechanical and Pneumatic Systems
5. Manufacturing Processes and Process Simulation.

The objective of the challenge is to develop the manufacturing of a component, involving the following stages:

1. Simulation and comparison of manufacturing processes for a component.
2. Development of a fixation system to measure the produced parts.
3. Analysis of GD&T limits to meet the part specifications.

For the challenge's development, students are organized into teams of five, with each team responsible for the following deliverables:

- CAD modeling of the part
- Manufacturing of parts using four processes: two casting processes, one CNC machining, and one conventional machining (Optional Additive Manufacturing)
- Simulation of processes used for part manufacturing
- Comparison of processes and materials for part fabrication
- Design, manufacturing, and instrumentation of the part measurement system
- APQP process documentation: a) Flow diagram, b) Process Failure Mode and Effects Analysis (PFMEA), c) Control plan
- Measurement and traceability/SPC system:
    - a) Measurement device,
    - b) Repeatability and Reproducibility Analysis (R&R),
    - c) Demonstration of process capability and control with an SPC system.

For the evaluation and selection of the part material and suitable manufacturing process based on quality concepts, each team must manufacture a part using each of the following processes and materials:

- Conventional Machining: Aluminum
- Conventional Machining: Nylamid
- CNC Machining: Aluminum
- Casting: Tin-Lead
- Casting: Aluminum
- Additive Manufacturing (optional): PLA

The resources available to students, provided by both the partner trainer and the university, include:

University Resources:

- Materials for silicone mold fabrication and tin/lead parts
- Materials for sand casting and aluminium alloy parts
- Blanks for lathe part manufacturing: Aluminium alloy and Steel
- Machine and material for FDM part manufacturing

Partner Trainer Resources:

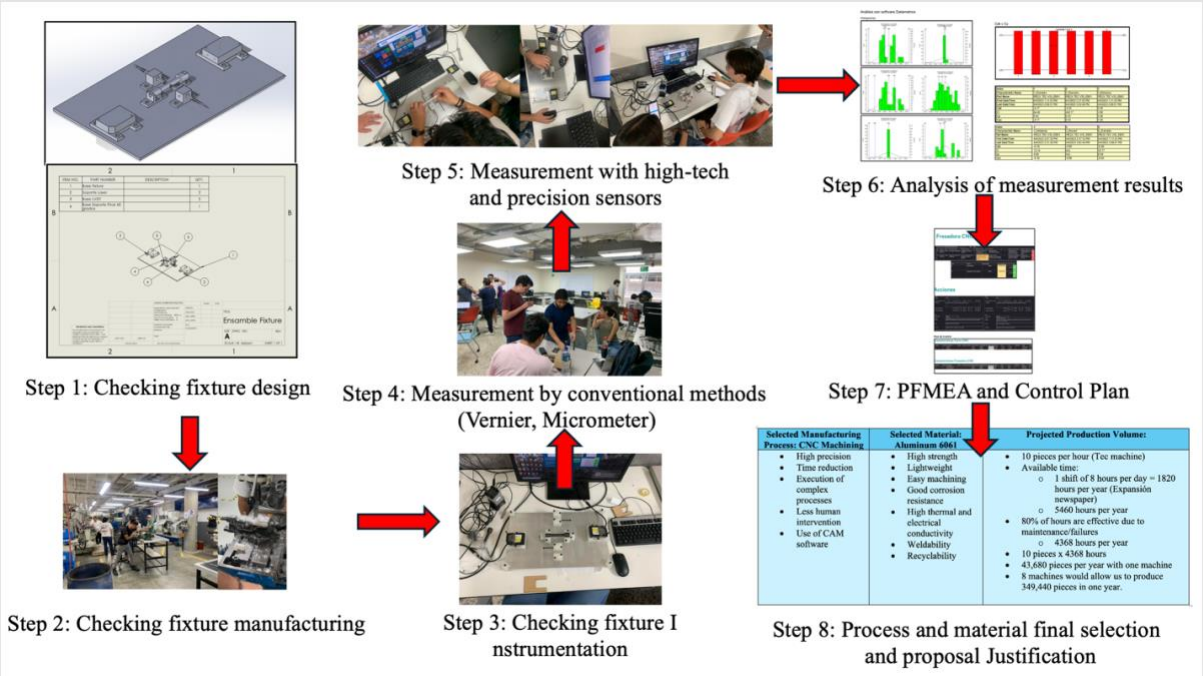
- 20 machined parts (10 steel, 10 aluminium alloy) for CNC machining analysis
- QDAX and Datametrics software licenses (APQP, MSA, SPC)
- Datmyte's Digital Clipboard licenses
- For each team: 2 LVDT sensors, 2 Laser sensors, 1 Data acquisition card, 1 Datamyte data collector, Part design to manufacture with different geometric specifications for each team.

Each team designs and manufactures its checking fixture based on the geometries to measure, instruments its checking fixture, and performs measurements and data collection.

The steps involved are:

1. Checking fixture design
2. Checking fixture manufacturing
3. Checking fixture instrumentation
4. Measurement by conventional methods (Vernier, Micrometer)

5. Measurement with high-tech and precision sensors
6. Analysis of measurement results
7. PFMEA and Control Plan
8. Process and Material Final selection and Proposal Justification.



ACTUAL OR ANTICIPATED OUTCOMES

The main anticipated outcomes as results of the manufacturing quality challenge applied are:

Development of Competencies and Skills: The experiential learning facilitated by the pedagogical implementation of Core Tools training enables students to develop a diverse set of competencies and skills essential for their professional growth. Through hands-on experimentation and collaboration, students refine their problem-solving abilities, enhance their technical proficiency, and learn to navigate interdisciplinary challenges inherent in engineering practice. Moreover, the partnership between academia and industry enriches the educational experience, exposing students to cutting-edge technologies and fostering a culture of innovation and continuous improvement.

Integration into the Labor Market: One of the primary objectives of Manufacturing Quality training is to enhance students' readiness for the labor market. Equipped with competencies aligned with industry needs, students are better prepared to embark on their professional journey upon graduation. By systematically evaluating options, optimizing production processes, and considering economic, technical, and sustainability objectives, students contribute to the competitiveness and sustainability of the manufacturing industry. Furthermore, their exposure to real-world challenges and

collaboration with industry professionals enhance their employability, positioning them as valuable assets in the workforce.

Implications for Lifelong Learning and Employability: The integration of Core Tools into engineering education not only prepares students for immediate employment but also fosters a culture of lifelong learning. By instilling a mindset of adaptability and continuous improvement, Manufacturing Quality training ensures that students are equipped to navigate the ever-changing landscape of engineering practice. Furthermore, their exposure to interdisciplinary challenges and collaboration with industry partners instills in them a sense of versatility and resilience, making them well-rounded professionals capable of thriving in diverse work environments.

CONCLUSIONS

In conclusion, Manufacturing Quality competencies in engineering education transcend mere technical proficiency, encompassing educational and pedagogical dimensions. By integrating these competencies into the curriculum, educators can cultivate a culture of lifelong learning and enhance students' integration into the labor market. This study underscores the transformative impact of some of Core Tools training in engineering education, preparing students to address the challenges of the manufacturing industry while fostering their competencies and skills for lifelong success. As engineering continues to evolve, the integration of Core Tools training remains paramount in shaping the next generation of engineering professionals poised to make meaningful contributions to society.

ACKNOWLEDGMENT

We extend our deepest gratitude to Automated Data Systems of Mexico for their invaluable collaboration in developing the educational methodology for our mechanical engineering capstone course. Their participation was crucial to the project's success, providing a solid foundation in evaluating and developing manufacturing systems aligned with economic, technical, and sustainability objectives. We sincerely appreciate their commitment and support.

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Global action learning for social impact: Preparing industry technical leaders of the future

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CONTEXT

The residential graduate education experience of future industry technical leaders and technical managers has the potential to function as a formative journey, wherein individuals internalize concepts surrounding culturally-sensitive solution design, and human social impact, within a business context. Presently, practicing engineers across global regions encourage future engineers to appreciate cultural perspectives and diverse backgrounds in order to be competent global engineers (Rodríguez-Simmonds, Sánchez-Peña, Atiq, Coutinho, and Jesiek 2019). Incorporating intentional intercultural learning into STEM-based courses enhances intercultural development for students, and is recommended as a method for increasing competency for career success in globally diverse workplaces (Wickenhauser and Karcher 2020). While it is not common for graduate engineering students to complete a study abroad experience, it is fortunately still possible to enhance intercultural competence through on-campus course-based intentional learning activities without traveling abroad (Krishnan, Jin, and Calahan 2021). Cumulatively considered, engineering students are poised to build critical intercultural perspectives and skills through purposeful "hands on" learning in credit-bearing coursework. One effective method for intentional education is known as action learning. Action learning is "learning from concrete experience and critical reflection on that experience – through group discussion, trial and error, discovery, and learning from and with each other" (Zuber-Skerritt 2002, 114-15). Action learning varies meaningfully from the traditional pedagogical model of knowledge being transmitted and received through information, theories, and research, opting instead for an approach wherein "learners themselves develop as experts on the problem or learning task, and on how to solve or conduct it" (115). Students engaged in action learning are doing so as individuals, simultaneously within a group or social context, and in a manner that builds job-related capabilities.

KEYWORDS: Action learning, experiential, intercultural, education, diverse, social impact.

PURPOSE OR GOAL

In sub-Saharan Africa, social challenges in nutrition, health, and gender equality persist. As a demonstrated pattern, Western solutions often fail to meet local demands, and development aid often serves more as part of the problem than the solution (Christensen, Ojomo, and Dillon 2019). Gaps in missing or insufficient infrastructure are increasingly addressed through young, local entrepreneurs. While female entrepreneurs play a role in the creation of sustainable welfare, according to The World Bank (2019), women entrepreneurs across sub-Saharan Africa continue to earn lower profits than men (34% less on average). Reasons for the disparity include gender discrimination, limited access to capital and assets, lack of a support network, and other social and self-limiting factors. In an effort to address this multi-faceted issue, The Bayer Foundation (2022) is supporting female entrepreneurs through its Women Empowerment Award with the goal of accelerating change in sub-Saharan Africa.

The current practice applies a research-informed practitioner approach to address social challenges with entrepreneurial solutions by aligning a range of global stakeholders from higher education, industry, and social enterprise organizations. The situation indicates compelling potential. Graduate engineering students would benefit from culturally-oriented applied learning opportunities, while female entrepreneurs and early-stage startups in sub-Saharan Africa may derive measurable benefit from project deliverables generated by graduate engineering students who also possess foundational business concept knowledge.

APPROACH

The Master of Engineering Management (MEM) residential graduate program at Purdue University is an industry-oriented curriculum focused on preparing students for upwardly-mobile technical leadership and management roles, including Consulting, Operations Management, Product Management, Project Management, Technical Program Management, Supply Chain Management, and more. Across the last three years, eighteen teams, comprised of 86 total Purdue MEM students have participated in the "Social Innovation and Business" action learning course. The purpose of the course is to offer students a credit-bearing, profile-enhancing, experiential learning project, wherein students effectively function as technical management consultant teams.

The action learning course is a multi-continental collaboration, including a mentor based in Portugal, partners in Germany (Bayer Foundation), subject matter experts at Purdue, and social enterprise partners in locations like Brazil, Ghana, Kenya, Mexico, Nigeria, Tanzania, Uganda, and United States. In close coordination with their social enterprise partners, who are primarily in the agriculture and healthcare sectors, project teams address "pain points" according to the "jobs to be done" model (Christensen, Hall, Dillon and Duncan 2016). Students are tasked with end-to-end responsibility for the project, from scoping through delivery, rather than being presented with a predefined objective and statement of work, as is more commonly the case with industry-sponsored projects.

Concepts and tools addressed during the course include emotional intelligence, lean startup principles, Social Business Model Canvas, SWOT analysis, design thinking, intercultural concepts, client relationship management, appreciative inquiry, enabling innovation, and Sustainable Development Goals from the United Nations.

ACTUAL OR ANTICIPATED OUTCOMES

Course impact metrics are considered via quality of deliverables, social enterprise partner feedback, and student academic and job success. Across the fourteen teams who have completed their action learning social impact course thus far, final project deliverables have included an ecofridge prototype that can be assembled with primarily local materials, a mobile healthcare clinic redesigned to serve an island community with consideration for unique ecological and socioeconomic conditions, a satellite imaging tracking program for surveying smallholder farmland boundaries, a more efficient warehouse layout and inventory management system for miller flour bag production, and more.

To date, 100 percent of students who participated in the action learning course have graduated on time, and 100 percent report a successful full-time job outcome within six months (or sooner) of graduation. Students who have participated in the course includes citizens from India, Kenya, Nigeria, Thailand, South Africa, and United States. Graduates of Purdue's Engineering Management master's program who have participated in the Social Innovation and Business project course are now building successful full-time industry careers with globally diverse companies, many in the Fortune 500, like Accenture, Airbus, Amazon, Amazon Robotics, Apple, Autodesk, Barclays, Cargill, Deloitte, Georgia-Pacific, Goldman Sachs, Lenovo, Micron, Rivian, Tesla, Walmart, and more.

Feedback from social enterprise partners during final team presentations frequently includes plans to pilot or implement proposed solutions. As the third year of the multi-continental collaboration is reached, an important action item is to reconnect with prior social enterprise partners to understand whether solutions proposed by the technical management consultant student teams were ultimately implemented, why or why not, and what has been the impact.

CONCLUSIONS

Graduate engineering students enrolled in an industry-focused master's program have a clear preference for action learning courses, as evidenced by the fact that demand for available course slots nearly always exceeds capacity. Furthermore, involvement appears to have a strong positive correlation to desirable academic and career outcomes.

The Social Innovation and Business course can serve as a model for replication or customization by other institutions of higher education seeking to enhance intercultural competency, provide engaging curricular options, and contribute to graduate job outcomes.

The incorporation of an intercultural competency assessment, such as the Intercultural Development Inventory (IDI), could be a useful tool for not only measuring intercultural competency progress resulting from the course, but to provide an additional mechanism for intentional intercultural learning into a STEM-based course.

Ultimately, perhaps the greatest long-term social impact for the course will be its influence on future technical leaders and technical managers in industry whose decisions about products, services, and sustainability will have real consequences, positive or negative, for human beings around the world.

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Impacting student´s learning by multidisciplinary teams

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CONTEXT

The world demands professionals who can work in multidisciplinary teams facing dynamic, complex, and uncertain environments (Kamp 2020). People often refuse to form close and trusting relationships with team members from different bachelor's degrees (Silva et all. 2021). Tec de Monterrey introduces a new learning methodology TEC21 and in the eighth semester, students participate in a multidisciplinary block where, together with students from other majors, they coexist to solve a challenge in a real company. For this study, it was decided that not only would they coexist to solve a challenge in a real company, but multidisciplinary teams would also function to receive the classes and workshops.

KEYWORDS: Educational innovation, higher education, problem-solving, multidisciplinary, teamwork.

PURPOSE OR GOAL

The purpose is to seek if there is a positively impact student learning when working collaboratively with students from other disciplines in terms of student satisfaction and student's academic grades.

APPROACH

This multidisciplinary block included students from three different bachelor's degrees: industrial engineering (18 learners), business administration (9 learners), and global business (10 learners). They interacted with the following six components: 1) knowledge based on three topics of each discipline's curricula, 2) a problem to be solved by students in a real company, 3) balanced multidisciplinary teams, 4) a logistic workshop, 5) a delivery workshop, 6) a 31 questions e-survey that included the student´s profile, student's learning progress, and the factors that most impacted the improvement in learning was conducted at final term. Data from qualitative e-survey were analyzed to gain insights into student experiences and academic progress.

ACTUAL OR ANTICIPATED OUTCOMES

Thinking on student´s satisfaction on working in multidisciplinary teams, through a dichotomous question asking whether students would recommend this multidisciplinary learning experience to future students, 29 responses (82.9%) were positive while 6 were negative. Students ranked six factors from greatest impact to least impact to identified the most influential factors in their learning process resulting the logistics workshop and working on multidisciplinary teams the most influential factors.

After comparing cumulative GPAs before and after the multidisciplinary block experience, an improvement was found going from 92.0 to 96.505. Furthermore, according to the students' perception, there was an academic improvement in each of the three different topics learned.

CONCLUSIONS

This study stands alone, and there's no information available to compare it with other experiences. As a result, future work derived from this analysis may focus on gathering comparative data to determine if there is indeed an enhancement in the learning experience.

This study serves as a reference for future research efforts to improve students' educational experiences.

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Industry support for education after COVID-19

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CONTEXT

The COVID pandemic forced both the educational and industrial sectors to work online, even today many companies work in a hybrid way. Working from home (WFH) has been maintained mainly because of the savings it generates for both the company and the worker (Holland, 2021), (Mousa, 2021).

However, WFH does not always succeed, especially in education. Several studies have demonstrated that this isolation led to various complications, including a significant educational gap. Moreover, this gap was even more pronounced when schools remained closed for extended periods (Jakubowski et al., 2024). Therefore, today it is not sufficient to merely return to the classrooms; we must actively seek or resume strategies that aid in recovering lost educational time and reconstructing what was missed.

On the other hand, in engineering, there is no doubt that one of the most powerful tools in the teaching-learning process is the integration of theory and practical work developed in the laboratory to solve real-world problems. Furthermore, when students are presented with practical industrial challenges, these take on greater relevance and become more attractive due to their direct application in industry.

However, what happens to the teacher when faced with these learning strategies? They are taken out of their comfort zone—moving beyond simply preparing classes and exercises—to adopt a new methodology that involves solving practical problems. This work addresses this topic.

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KEYWORDS: Academic-industry partnerships, Challenge-Based Learning, teaching-learning process, Industrial Automation, COVID pandemic.

PURPOSE OR GOAL

Recently our institution experienced a significant transformation by moving from a traditional study model to one that emphasizes competencies and challenges. In the context of the challenge-based learning (CBL) technique, students apply their knowledge to solve real-world problems (Membrillo-Hernández et al., 2023). This is the objective pursued in the Industrial Automation subject: that students taking this course solve practical problems directly related to the industrial field. As a result, we actively seek the support of leading companies within this sector.

However, due to the problems posed by the pandemic, few companies have the resources and/or want to support Universities in the development of these activities. The above requires designating budgets for these activities, since it implies the designation of personnel so that, in coordination with teachers, they design, apply, and evaluate project proposals throughout the course. Adding to this challenge is the situation where teachers lack experience in these types of activities, do not have business contacts, or have not engaged in training or consulting related to industrial work.

The objective of this work is to support teachers who are embarking on this process. In this study, we present and analyze important points that the authors encountered while developing these types of activities in collaboration with industry. Elements from the search and selection of companies to the implementation of the challenge, in general, the problems faced and the way in which they were solved.

It is hoped that this work will serve as a guide for educators wishing to implement these teaching methodologies with industrial partners. Without a doubt, this teaching strategy helps to better prepare students by supplying them with the skills and knowledge required in today's industrial world.

APPROACH

Although the challenge will be solved by the students, it is necessary for the teacher to know and understand the issues required to address and solve the problem. At many points in the project, the student will doubt the proposed solution, so feedback, both from the teacher and the company engineer, plays a predominant role for the success of the project.

The challenges were implemented in the subject of Industrial Automation, this is part of the study plan of the Mechatronic Engineering degree. Because it is taught annually, only two generations of the new model have taken this subject. The first project was carried out with GENERAC in 2022, a world-leading company in Generators, and the second project in 2023 with Rockwell Automation, a leading company in Automation.

In both projects, the commitment of the engineers assigned by the companies to the learning methodology was extremely important. Their advice, evaluation time, scheduled visits, and workshops conducted during the course demonstrate their strong commitment to education.

ACTUAL OR ANTICIPATED OUTCOMES

When selecting companies, those related to the topics taught in the course should be located first and, if possible, as close to the Institution so that it is easy to visit them, in other words prioritizing the companies is the first step. Not only the students will visit the company, but also the professor to review progress, equipment, training, etc.

Elements that must be clear and established in the first meeting with the company:

- Teacher’s Role: Clarify that the teacher will not directly solve the problem.
- Challenge vs. Consulting: Emphasize that the challenge is not a consulting project; it’s a learning opportunity for students.
- Student Responsibility: Highlight that students will solve the problem themselves, which may lead to diverse solutions based on their experiences.

What will the company get?

1. Student Identification: Companies can identify potential recruits among participating students.
2. Brainstorming and Innovation: Engage in brainstorming sessions with students to explore possible solutions.
3. Equipment Training: Students can be trained in using the company’s equipment, ideally with prior exposure at school.
4. Brand Positioning: By collaborating, the company’s brand becomes associated with student projects, leaving a lasting impression.

The equipment and programs that will be used in the development of the project are fundamental in its selection. Does the school have these devices? If you have them, how many devices are available? If you don't have them, will the company provide it?

Another important element is making straight the project with the course objectives. Sometimes the company has projects that are easy to solve, but that do not cover the course topics. The opposite also happens, in such a way that the project must be limited; It may also happen that it does not cover any topic in the course program. Course objectives and intent, as well as learning outcomes, should be reviewed

before selecting a project. A project that covers 100% of the course topics would be ideal, but in most cases this does not exist.

CONCLUSIONS

The knowledge and skills that the student acquires and develops with this type of projects are very important and diverse. However, in this case, the most valuable thing was the teacher's learning, since these types of activities take him out of his comfort zone, since not all projects are the same. The experience acquired is what is poured into this work.

An essential aspect in this type of work is the support provided by engineers from collaborating companies. Your willingness to exchange experiences, dedicate time to consulting and actively participate in the project is extremely important. Without your commitment, this activity simply could not be carried out.

In this type of projects, the companies win by making their products known and meeting students they can attract, the students win by seeing that their knowledge can be applied in real solutions and the teacher, by gaining experience.

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Insights of STEM students' competencies: The case of Tecnologico de Monterrey

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CONTEXT

Promoting and evaluating sustainability competencies among STEM students in modern higher education institutions (HEIs) is crucial. Incorporating these competencies into STEM education fosters a comprehensive understanding of the interrelationships between innovation and the environmental, social, and economic aspects necessary for lifelong learning (Žalėnienė and Pereira 2022). STEM students are pivotal in driving sustainable development both now and in the future. Therefore, their abilities in sustainability not only influence their academic achievements but also their capacity to address environmental, economic, and social sustainability challenges.

Recently, university STEM programs have increasingly focused on transitioning towards a green economy and sustainable research and innovation practices (Ozalevli 2023). Building value-based competencies, alongside academic knowledge and technical skills, is essential for nurturing a culture of sustainability among students (Žalėnienė and Pereira 2022). Implementing this combination can be achieved through STEM curricula that emphasize social responsibility, ethical leadership, integrity, critical thinking, and empathy.

Many higher HEIs have noted their important role in training and assessing sustainability competencies in professional students and lifelong learning (Redman *et al.* 2021). One of these universities is Tecnologico de Monterrey. It is a Mexican private institution engaged with the evolution of education and its social impact. In 2019, Tecnologico de Monterrey launched its Tec21 pedagogical model (Olivares *et al.* 2021). This model orchestrates the training and evaluation of competencies with high flexibility. However, the complexities of a flexible, adaptable, and multi-modal academic model state challenges for implementing such competencies and their evaluation. Therefore, analysing the results of the sustainability competencies of a flexible program demands multiple efforts using current methods based on data science.

Aiming to improve the educational model Tec21, Tecnologico de Monterrey has published a research call named Fostering the Analysis of Competency-based Higher Education, making available the data. The data description advances researchers with the challenges for the data science techniques.

- Information has been anonymized.
- There are string attributes with several labels and null values.
- Several records belong to the same student.
- The data of the Science and Engineering School have more than 4 million records about student competencies evaluation.
- Observations were acquired from August-December 2019 to February-June 2022, including six of the eight semesters of the programs, so there is no full cohort data.

While previous research has emphasized the relationship between competence assessment in undergraduate programs and their impact on lifelong learning, there remains a notable gap in the specific evaluation of sustainability competencies within higher education STEM courses. For instance, Nguyen and Walker (2016) explored the alignment of assessment practices with lifelong learning in universities but did not delve into the specifics of sustainability competencies. Segui *et al.* (2023) analysed the challenges of evaluating transversal competencies in STEM courses, highlighting the complexity and importance of active methodologies for competence development, yet without a focused analysis on sustainability competencies. Hakansson *et al.* (2024) discussed the broader transformation in higher education towards

lifelong learning, emphasizing the need for universities to ensure that graduates possess essential competencies. However, this work does not address how these principles apply specifically to sustainability competencies. Existing literature, such as Redman *et al.* (2021), has reviewed the assessment methods for sustainability competencies, identifying a variety of tools but leaving gaps regarding their practical application in large-scale datasets. Annelin and Boström (2022) highlighted issues with self-assessment instruments for sustainability competencies, pointing out the confusion around scales and criteria but did not leverage extensive data records for a more comprehensive analysis. Therefore, there is a need for research that utilizes data science techniques to analyse extensive datasets, such as 159,482 records of higher education STEM students' evaluations, to provide a deeper understanding of sustainability competencies assessment and its impact on lifelong learning.

KEYWORDS: Sustainability competencies, Data science competency analysis, Higher Education, competency assessment analysis, Competencies for lifelong learning.

PURPOSE OR GOAL

We have assumed the hypothesis that by applying data science techniques to the data collected by Tecnologico de Monterrey, we shall be able to shed light on the relevance of each attribute for the sustainability competence assessment and the behaviour of such competencies assessment by periods, programs, and academic year. Our work aims to determine a reasonable explanation of the relationship between the attributes recorded for each sustainability competence and its evaluation. We grouped the database features into three categories sociodemographic, academics, or competencies.

APPROACH

We have developed a six-step procedure. Such a procedure is based on the CRISP-DM methodology for data analysis. Step one, Management and ethics has been transversal through the research work. We have understood the criteria for assessing competencies at Tecnologico de Monterrey in step 2. Once we reached an understanding of the business, we proceeded with the data comprehension in step 3. We modified the database to obtain a tidy dataset in step 4. Next, we applied correlation analysis, feature selection algorithms, and feature engineering to create worthy features and drop those unnecessary. In step 6, we have determined the relationships between academic, sociodemographic, and competence data.

We analysed, with data science methods, 159,482 records about assessing 17 sustainability competencies in 22 STEM programs between 2019 and 2022.

1. Commitment to sustainability
2. Application of international standards
3. Hydraulic systems design
4. Structural design
5. Social Intelligence
6. Ethical and citizen commitment
7. Chemical process design
8. Generates comprehensive energy solutions.
9. Evaluate the availability and restitution of natural resources.
10. Bioproduct development
11. Innovation Management
12. Innovation of organizational processes
13. Bioprocess design
14. Bioreactors design
15. Evaluation of sustainable technologies in biosystems
16. Integration of productive biosystems
17. Design corporate sustainability strategies

These competencies implement the sustainable development goal of the United Nation SDG Target 4.7 (UNESCO 2020) “ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development.”

ACTUAL OR ANTICIPATED OUTCOMES

The academic programs at Tecnologico de Monterrey are flexible and multi-modal, as are current trends. Thus, students can take different subjects in different semesters and modes, face-to-face, remote, or hybrid.

We have found that sustainability competencies are highly distributed among all semesters and academic programs, 93.5% of the students are assessed in at least one sustainability competence at the end of the first semester, 96.7% at the end of the second semester, and 97.2% at the end of the third semester. Almost all the students who haven't been assessed in a sustainability competence by the third semester neither finish the academic program. Students finishing their sixth semester have been assessed an average of 21 times with three difficulty levels.

We have noticed no differences regarding gender, age, or nationality in developing sustainability competencies. Figures 1-3 depict the Cramér's V and p-val for the correlation between each nominal variable and the competence evaluation variable, which takes dichotomous values -observed or not observed-. All Cramér's V values indicate very low correlation between the independent variable and the competence evaluation.

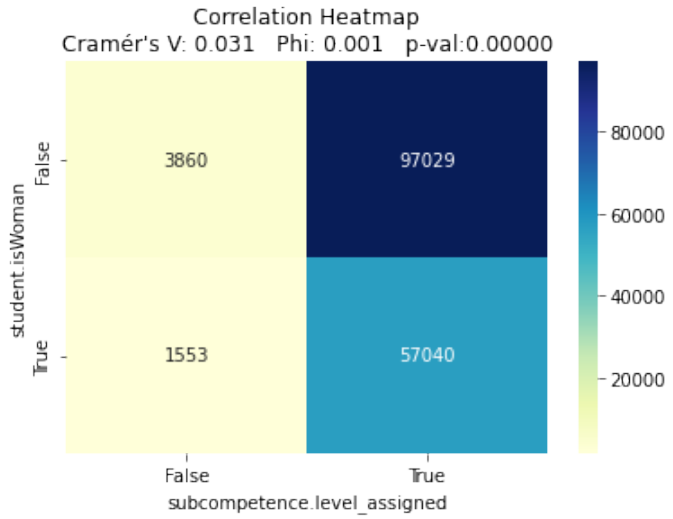

Figure 1. Correlation between gender and competence evaluation.

CONCLUSIONS

After analysing the data, we conclude that STEM students at the School of Engineering and Science in Tecnologico de Monterrey have sufficient competence training and assessment in sustainability since the first-year academic program. Besides, we have noticed that the academic model and the professors do not present bias regarding the student's gender, age, or nationality, which helps students' competencies training with a good example of social justice.

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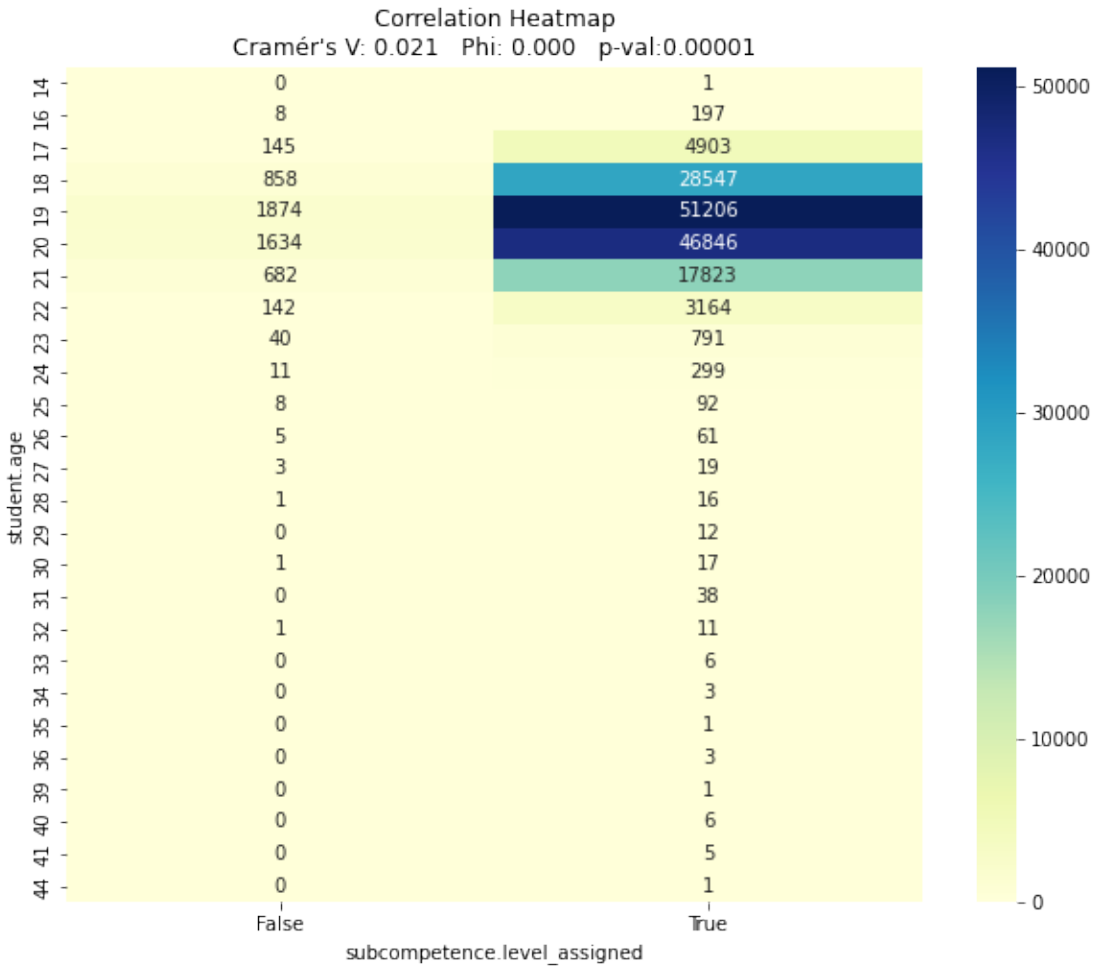

Figure 2. Correlation between age and competence evaluation.

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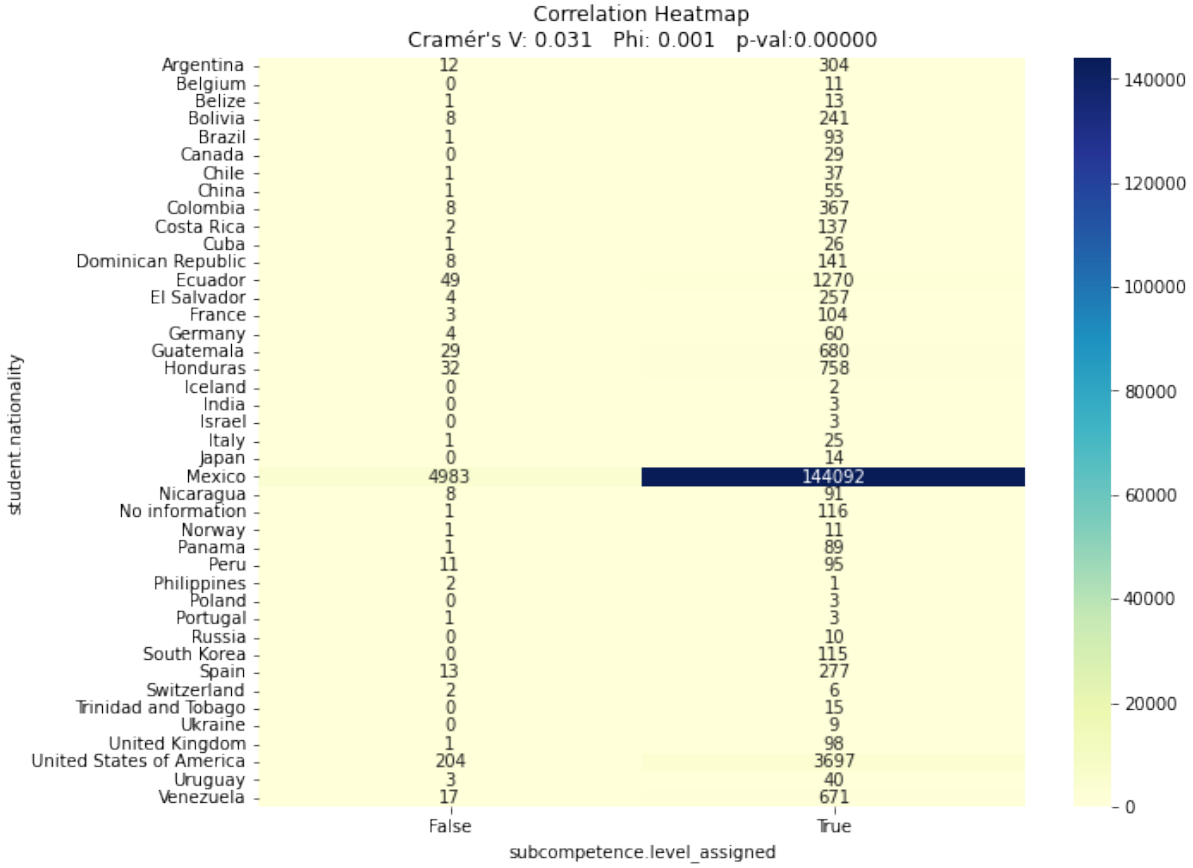

Figure 3. Correlation between country and competence evaluation.

Internationalization experience for the enhancement of continuing engineering education

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CONTEXT

Science and technology have an evolutionary nature. In the twenty-first century, their evolution rate has increased exponentially. This fact forced engineers to keep learning widely throughout their lives. In this address, the National Academy of Engineering (NAE) has stated the relevance of designing "a corporate and national strategy […] for lifelong learning for our engineering workforce." This valuable proposal might start designing an educational model (National Academies of Sciences, Engineering, and Medicine 2018).

Multiple challenges for continuous engineering education have been identified in the literature. For example, the need to adapt traditional teaching methods to the objectives of engineers under different conditions (National Academies of Sciences, Engineering, and Medicine 2018); the demand for a continuously updated interdisciplinary curriculum (Qiu 2010; Ktoridou & Eteokleous 2014); the required flexibility on where, when, and how to learn (National Academies of Sciences, Engineering, and Medicine 2018); the need to simultaneously develop a wide range of professional skills and a deep scientific and technological knowledge (Viegas et al. 2021; Ktoridou & Eteokleous 2014); and an effective assessment methodology for this different educational environment (Viegas et al. 2021).

Current work offers continuous engineering instructors and trainers with insights, methodologies, and innovative practices that could help them design an educational model for engineers along their career pathways. It investigates the perception of undergraduate students about the components of the TEC21 model during their international experience.

The four pillars of Tec21:

Four components or Pillars sustain the values of the Tec 21 educational model: flexibility, challenge-based learning (CBL), vivency and memorable experience, and inspiring professors (ITESM 2016). The Tec21 model focuses on competency-based education; the four components function as the structural reforms that permit the transition towards integral education (Olivares et al. 2021).

The idea of a flexibility component is to allow the students to decide on a series of options that will affect their curricular trajectory and personalize their learning experience (ITESM 2016). The view Tec21 has of CBL is that students develop their competencies while working on finding the solution to different real-life situations (ITESM 2016); it creates a relationship between the theoretical concepts that are reviewed during class, the relationship with the professor and the overall environment where they can apply what is learned (Olivares et al. 2021). CBL permits students to experience applying their knowledge as individuals who collaborate with their peers to find an alternative to each challenge (Olivares et al. 2021).

Thirdly, there is the vivency pillar which attends to the necessity of having a memorable university experience by adding co-curricular programs that contribute to an overall integral education (ITESM 2016). To correctly apply the basis of this Tec21, it is necessary to count with a solid faculty. The fourth pillar of this educational model is to have inspiring professors who are professionally developed in their area, who have a connection with academia (research, educational management, or both), and who are innovative and well-developed in the use of technology (Olivares et al. 2021). In addition, the professors have several

roles: they fulfill professorship, act as tutors for students, are evaluators of the performance of students' apprenticeship, design challenges that comply with CBL, and finally, perform as mentors that accompany and orient students (ITESM 2016).

KEYWORDS: Tec21, competency-based education, educational models, studying abroad, higher education, educational innovation, lifelong learning.

PURPOSE OR GOAL

This study aims to understand how the Tec21 educational model, specifically its four pillars, helps students acquire valuable skills and competencies to accommodate and compete internationally with their peers in an academic atmosphere and gain values that will help them adapt to the world's constant changes. It was hypothesized that if we evaluate the students' perceptions of their international exchange program, then: 1) we will evidence of how Tec21 prepares students for a lifelong learning proficiency that will be helpful for any professional and personal environment they might face, and 2) we will provide insights on effective components that could build an Educational Model for continuous engineering education.

APPROACH

A series of 43 open questions was designed to gather information by conducting semi-structured interviews with thirteen students who chose to enroll in an abroad study program during their seventh semester of a career in engineering and sciences. The interviews were held via video conference since the students were still coursing their international experience; these were recorded and later transcribed to facilitate the collection of valuable information. Afterward, the transcripts were analyzed, and the useful data was organized into tables to visualize the most important results and interpret them correctly.

ACTUAL OR ANTICIPATED OUTCOMES

The analysis of the interviews revealed that using different technologies for exams and classes stands out as a reflection of the flexibility component. Although most universities have similar teaching strategies, students describe that challenge-based learning in Tec21 connects the theory to real-life problems and provides exposure to working with external organizations from the early semesters. In the case of inspiring professors, Tec's smaller classes fostered closer student-teacher interactions, thereby facilitating a more personalized education tailored to each student's unique needs. Limitations for this study complicate understanding the personal experience pillar; nonetheless, most students described a similar experience studying abroad as they do at Tec.

CONCLUSIONS

The evaluation of the four pillars of Tec21 permits understanding the capabilities and aptitudes that help engineering students overcome challenges such as the internationalization program. Current research reveals new information to improve teaching strategies that can be implemented into continuous education to train skilled and competent engineers.

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Navigating Digital Competence in Higher Education: Analyzing Instrument Design and Validation for Industry 5.0

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CONTEXT

When we refer to Industry 5.0, the use of robots and AI to enhance productivity and economic growth came into our minds as stated by Kemendi, Michelberger, and Mesjasz-Lech (2022). This new phase involves a synergy between human creativity and technological precision based on human centrality, sustainability, and resilience. Technological advancements enable a collaborative work environment between advanced technology and human ingenuity, essential for global prosperity (Leng et al., 2022). In this context, the pressing need for future professionals to possess robust digital competencies to interact with intelligent machines effectively is recognized (Xu et al. 2021), alongside the emphasis on soft skills such as communication (George-Reyes, Peláez-Sánchez and Glasserman-Morales, 2024), creativity, collaboration and critical thinking (Ungureanu, 2020). Corporations and educational institutions must take a holistic approach to training their workforce to adapt to emerging roles demanded by Industry 5.0. (Matsumoto-Royo, Ramírez-Montoya, and Glasserman-Morales, 2022). Engineering professionals must have technical knowledge and interpersonal skills to lead in Industry 5.0 (Ahmad et al., 2023; Bakkar Kaul, 2023). This approach develops a sustainable industrial ecosystem where education prepares individuals for changing work environments (Ghobakhloo et al., 2023). Continuing engineering and higher education must be rethought to develop skills for adapting to technological changes, including creativity, communication, teamwork, and leadership (Suciu et al., 2023).

KEYWORDS: Digital competencies, soft skills, instruments, Industry 5.0, higher education, Innovation in Education

PURPOSE OR GOAL

Measuring students' digital competencies is important to prepare higher education institutions for Industry 5.0 skills and expectations. Identifying comprehensive instruments that evaluate digital competencies and other essential skills is crucial. The prior systematic mapping highlighted higher education as a consistently analyzed scenario. Instruments designed to validate digital competencies in higher education that connect with the key competencies for Industry 5.0, such as creativity, communication, collaboration, and critical thinking, need to be identified. Thus, this study aims to identify if there are specific instruments that comprehensively address the digital competencies and soft skills necessary for Industry 5.0, relevant to higher education, especially for engineering students.

APPROACH

This study followed a systematic literature review (SLR) based on the methodology of Kitchenham and Charters (2007) to establish an overview of existing digital competency assessment instruments in higher education and their core competencies of Industry 5.0 from 2013-2023. The search strategies focused on a) search strings "Digital skills" OR "Digital competence" OR "Digital competencies" AND ("Validation" OR "Validated instrument") AND ("Measurement" OR "Assessment" OR "Instrument" OR "Scale" OR "Tool" OR "Questionnaire" OR "Survey"), b) databases (ERIC, Google Scholar, ProQuest, Scopus, and Web of Science), c) time frame (2013-2023), d) type of document (unspecified), e) languages (Spanish and English), and f) field of study (Education). The inclusion, exclusion, and quality criteria of the literature

review were specifically aimed at identifying and analyzing instruments that comprehensively address the assessment of digital competencies in higher education.

RESULTS

The data analysis involved a search strategy applied to various databases, resulting in a total of 9,563 academic papers. After applying inclusion, exclusion, and quality filters, 112 articles were selected and analyzed, with 46 documents focused on the design and validation of digital competency assessment tools in higher education.

The research indicates that communication competence is the most important skill that digital instruments focus on, and many of these tools follow the frameworks of Digital Competence Framework for Citizens (DIGCOMP) or Digital Competence Framework for Educators (DigCompEdu) (UNESCO 2018). This indicates that this competence is recognized as significant in the digital age, especially for effective participation in the collaborative work environments projected by Industry 5.0.

It was found that there is a need to assess the soft skills required by Industry 5.0 apart from the digital competencies. These soft skills include creativity, critical thinking, and collaboration. This finding has highlighted an important gap in evaluating digital competencies, stressing the need to develop effective instruments that integrate digital competencies with essential soft skills. These skills are extremely important for adaptability and innovation in the industry 5.0 work environment. Furthermore, these instruments should be related to higher education to guide professionals and engineers more effectively toward efficient integration into Industry 5.0.

It is worth noting that while many studies have focused on students, 39.13% of them have evaluated teachers' digital competencies. This highlights the importance of considering educators in developing and evaluating digital competencies, given their crucial role in preparing students for the challenges of Industry 5.0. This focus distribution emphasizes the need for a comprehensive strategy that includes students and educators in developing digital competencies and soft skills.

CONCLUSIONS

In conclusion, it is essential to develop valid assessment tools that cover a range of competencies including creativity, communication, and collaboration. This will align higher education with Industry 5.0's vision for a sustainable, human-centric future. Involving students and educators in developing digital competencies and soft skills is crucial. Future research should create tools that measure technical and soft skills in dynamic work environments.

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On-site Inspection as a Tool for Developing Auditing Skills in Engineering: Integrating Continuous Education Contents Into Higher Education Programs

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CONTEXT

Employability is related to the ability to demonstrate a good performance in the workplace based on specific expected skills and abilities (Thapa, 2024). This term has been a priority for higher education institutions that strive to continuously design, implement, evaluate, and improve their students' curricula to match the industry's current expectations and requirements. Simultaneously, industrial employers are constantly setting a competitive scenario, flanked by the need for leaders who can cope with the challenges arising from the continuous development of technology. In some cases, higher education institutions set specific standards to measure the acquisition of employability skills; however, as the students start moving into the workplace, the transference of those skills is somehow more complex to record (Jackson, 2014).

Unemployment represents an important challenge, especially in developing countries, as one of the main attributed reasons is the existing gap between the pragmatic knowledge provided by higher education institutes and the workplace requirements. Additionally, employers occasionally trust that universities are responsible for providing the desired skills to their graduates (Tushar and Sooraksa, 2023). Nevertheless, different opinions among educators have taken place when determining if universities are either places for developing capabilities, in which the students acquire disciplinary knowledge, while competencies are acquired at the workplace through practice, mentoring, and continuous education, or if higher education institutions should be reinforced with applied knowledge to build work-ready graduates with a complete set of skills (Jackson, 2014). In developing countries, employability skills are more directly related to productivity, job opportunities, and economic and industrial advancements (Mukul *et al.*, 2024). For this reason, universities in emerging economies are modifying and improving their educational programs to prepare their students in accordance with the market demands (Arredondo-Trapero *et al.*, 2024).

One of the main required employability skills in engineering is applying theory to solve real industrial problems (Morgan and O'Gorman, 2011). This can be accomplished by integrating problem-based learning that not only increases the effectiveness of education through practice but also promotes the obtention of employability skills such as communication, teamwork, and leadership, among others (Othman *et al.*, 2017). Another important aspect is the development of technical competencies, which is linked to an increased analytical capacity and desirable aptitudes that graduates can apply to real industrial problems (Morgan and O'Gorman, 2011). Likewise, work-based learning is focused on learning for, at, and through work, which could result in networking, employment opportunities, and, most importantly, the development of work-related technical, generic, and personal skills (Thapa, 2024).

Furthermore, some employability skills necessary for graduates include the ability to analyze different processes to diagnose problems, which eventually must be derived into decision-making for improvement. Analysis, reasoning, intuition, and experience can be highly valued by managers, who also expect a degree of troubleshooting and decision-making abilities in their new employees (Solís, Mohedano and Torres, 2024). An opportunity to acquire and practice the aforementioned skills occurs during auditing, which can be applied in areas such as production, health and safety, food safety, quality assurance, and environmental responsibility. However, depending on the universities' capability, curricula, and

infrastructure, those auditing skills are usually not enforced unless the student can apply them as part of an internship, a thesis project, or after securing a job in this area. Yet, a significant element to ensure employability is the inclusion of professional qualifications throughout higher education studies (Herath and Ekanayake, 2024), which are commonly achieved as part of continuous education content.

In this regard, considering the factors arising from the industry 5.0 changes, engineers should receive transdisciplinary and continuous education to ensure that both knowledge and skills are achieved by the students, mainly by adapting the curriculum to the high-speed changes and disruptions of the globalized society (Gürdür Broo, Kaynak and Sait, 2022). In the auditing context, compared to recent graduates, many experienced auditors spend years of practice as well as participate in diplomas and certifications, which could increase the already existing gap between recent graduates and senior auditors regarding those skills. Therefore, the integration of different continuous education contents at a higher education level might enhance the employability opportunities of engineering students, in which an evaluation of the effectiveness of this strategy should be considered. In this work, the students implemented a Food Safety and Food Quality checklist to analyze and resolve a real-life industry case through an auditing exercise. The problem-solving effectiveness of these instruments was assessed by collecting the feedback of an experienced auditor, as well as a representative from the audited company, to determine if the application of continuous education content through work and problem-based learning is effective for providing work-related skills to the students.

KEYWORDS: auditing skills, continuous education, higher education, engineering, employability.

PURPOSE OR GOAL

In this work, the implementation of a Food Safety and Food Quality checklist was performed by the students to analyze a real-life industry case. The problem-solving effectiveness of these instruments was assessed by collecting the feedback of an experience auditor, as well as a representative from the audited company.

APPROACH

The selected group was part of the Design of Process and Food Safety Management Systems class (Course code: TA2006B.301), which was taught in Spanish between August and December of 2023, as part of the fifth semester of 25 students from the Food Engineering Program at Tecnológico de Monterrey, Campus Monterrey (Monterrey, Mexico). This class was chosen due to the scope of the assessed competencies and the opportunity to apply a real work-based challenge in partnership with an industrial company. The evaluated competencies and the challenge are outlined in Table 1. As noted, the competencies included decision-making and problem-solving, which are employability skills highly required for auditing. The selected food industrial company was a beverage company that participated as a Training Partner, specific information regarding the company is not shown due to confidentiality however, this company allowed access to their quality assurance and food safety records, along with the application of the food safety audit instrument during an inspection visit by the students to their facilities. and how it was analyzed or could be used to justify the study.

Before the audit instrument generation, the students received two continuous education courses provided by Secretaría de Salud from the Nuevo León state, which is regarded as the Mexican Ministry of Health. This organization provides an Online Training System (https://saludnl.gob.mx/regulacion-sanitaria/cursos/), from which the two courses consist of Hazard Analysis and Critical Control Points (HACCP) and Good Manufacturing Practices (GMP's). The fulfillment of both courses was proven by an exam with a minimum approbatory grade of 80/100 and the obtention of a certificate.

Based on the Mexican regulation NOM-251-SSA1-2009 Hygiene Practices for Food, Beverage, and Supplement Processing, the continuous education courses, and the process particularities from the Training Partner, the students prepared a checklist with all the applicable HACCP/Food Safety and Hygiene aspects. Each team formulated its instrument, and all the audited elements were classified in sections or listed as a whole document.

The students visited the Training Partner facilities located in Monterrey, Nuevo León, Mexico. They inspected the areas and processes by marking the expected compliances as indicated in the checklist instruments. Once the inspection and checklist were completed, the overall audit grade was calculated according to Equation 1.

$$Audit\ Grade = \frac{Complied\ Points}{Total\ Applicable\ Points} * 100 \qquad \text{(Equation 1)}$$

An experienced senior auditor simultaneously visited and audited the company by revising 28 sections. The checklist result was received, and the audit grade was calculated according to Equation 1. A graphical comparison was made between the auditor's grade and the students' results.

The percentage of approximation between the student's instrument and the auditor's grades was calculated according to Equation 2.

$$Grade's\ Approximation\ = \frac{Instrument's\ grade}{Auditor's\ grade} * 100 \qquad \text{(Equation 2)}$$

An online survey was provided to the owner of the Training Partner company to obtain the company's perception and feedback on the effectiveness and pertinence of the implemented audit exercise. The survey was sent and answered in Spanish through RedJade and consisted of 10 questions, where only the name (Q1) was covered due to confidentiality.

All the statistical analysis was performed in Minitab 21.4 Statistical Software.

ACTUAL OR ANTICIPATED OUTCOMES

The audit grades calculated by the students are indicated in Table 1. Regardless of the number of sections, all the instruments aligned with the corresponding legislation and revised the same scope of checklist points. The average audit grade given by the students was 67.04 ± 8.92, with a range of 27.34, and minimum and maximum values of 52.42 and 79.76, respectively. The average group grade was close to the assigned grade from the senior auditor (72.94), which indicates a good estimation from the instruments generated by the students. In engineering, audits are essential elements within the companies, as they prevent risk and reduce losses, which positively impacts overall competitiveness (Wang and Li, 2011); hence the pertinence of the instruments is a good indicator of the capability of the students to identify, propose, and solve real industrial problems.

Table 1. Team distribution, food safety checklist instrument's specifications, and audit results.

Team Number	Team Conformation		Audit Instrument Description			
	Male	Female	Number of inspected sections	Total Applicable Instrument Points	Complied Points	Scaled Audit Grade (0-100)
1	0	4	2	98	65	66.33
2	2	2	12	101	65	64.36
3	2	3	15	55	38	69.09
4	2	2	14	42	33.5	79.76
5	2	2	2	62	32.5	52.42
6	0	4	20	96	67.5	70.31
Auditor	0	1	28	109	79.5	72.94

As noted in Figure 1, only for Team 4 the company surpassed the senior auditor grade. In contrast, the audit results from Teams 1, 2, 3, and 6 were lower than the auditor's result, yet within the same range of compliance. In the case of Team 5, the final grade was lower (52.42) than that of the other teams due to the stricter approach from the students in this team. Nevertheless, all the teams had the opportunity to receive feedback from the senior auditor and a space to present the results to the Training Partner, in which the company's feedback was given, and the students could homologate the expected audit approach for further interventions. This type of academic exercise is appropriate for developing employability skills. Most students were evaluated with an outstanding level of accomplishment for competencies SEG0300 Collaboration and SEG0303 Effectiveness in negotiation, which are linked to collaboration among team members, decision-making for problem-solving, and value generation in their results. Assets such as communication, problem-solving, leadership, and decision-making have been indicated as engineering skills highly required in developed countries (USA, UK, Australia, Japan, EU), where an agreement between higher education institutions and employers has been proposed as necessary for determining a common perception and development of these graduate skills (Zaharim *et al.*, 2010).

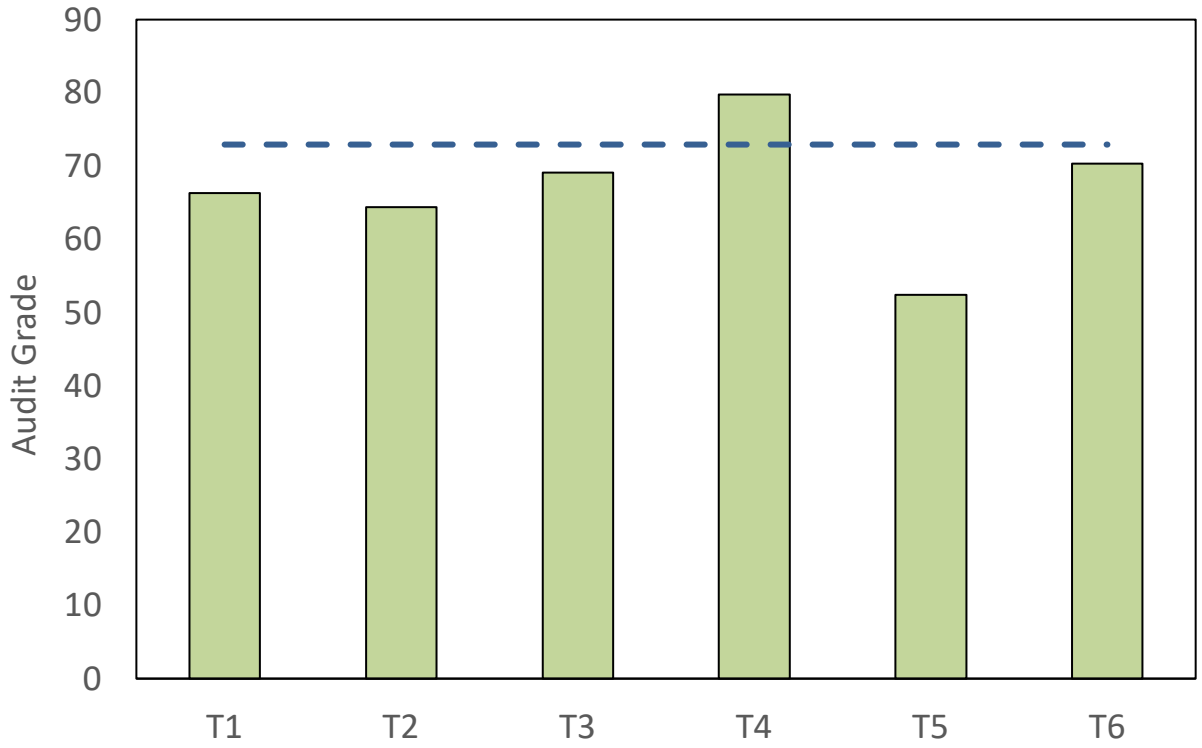

Figure 1. Audit grades given by the students in teams (green bars) in comparison to the audit grade provided by the senior auditor (blue dotted line).

A key element when developing employability skills is the generation of fully aware and self-conscious students who can identify their skill set and the opportunities to work on for improvement. In this framework, an important action of higher education institutions for reducing the academia-industry gap is allowing and promoting awareness and self-analysis in the students to empower them by creating the ideal space and structures to acquire the desired skills (Kaushal, 2011). In this regard, during the whole class length, all the team members performed three self-assessments and co-assessments based on the work-based challenge. This represented an opportunity for the students to mature self-awareness regarding their performance and improve their skill achievement.

Work-based challenges are a good opportunity for practicing soft and technical skills (empathy, communication, knowledge, management) that are highly correlated to the market and employers' needs

(Ajit and Deshmukh, 2013). They are proposed in line with a more practice-oriented pedagogy that can permeate engineering programs and be enriched with skill-oriented courses (Shekhawat, 2020). For this reason, integrating continuous education courses from an official organism such as Secretaría de Salud was appropriate for contextualizing and preparing the work-based challenge, as these courses add value to the curriculum vitae and provide applicable and transferable knowledge to the students. These types of courses are usually taken by employees and recent graduates, depending on the company's needs. However, their inclusion in higher education courses is a chance for the students to face and immerse themselves into real industrial needs and their expected performance in the work environment.

The combination of continuous education with a work-based challenge functioned as a laboratory for the students, where they can obtain technical knowledge in combination with fundamental, personal, and cooperative skills, which are recognized as necessary for the success of the employees towards the new challenges from globalization (Idkhan *et al.*, 2021). As the Técnológico de Monterrey enables a whole on-campus experience towards human and professional flourishing, the focus of this implementation is far from the industrialization of the curriculum or the specific industrial-oriented curriculum from technical schools. Despite the latter, the high approximation percentage outlined in Table 2, where the students accomplished similar results accounting for 71.87-109.35 % of those from an experienced auditor, demonstrated the effectiveness of this exercise on the students for performing accordingly and delivering the expected outcomes in front of a real industrial challenge.

Table 2. Approximation between the student's and the auditor's audit grade and final grades obtained by the students.

Team number	Approximation with the Auditor's grade (%)	Audit Activity Grade	Final Course Grade
1	90.93	98	96.75 ± 2.63
2	88.23	91	90.25 ± 3.59
3	94.72	96	96 ± 0.50
4	109.35	100	97 ± 2.16
5	71.87	99	95.75 ± 1.26
6	96.40	97	94.25 ± 1.89

Apart from the technical validation from the comparison of the students' grades with the result from an experienced auditor, the audit exercise grade assigned by the teachers corresponded with the final course grades (r=0.915), which are presented in Table 2. On the contrary, no correlation was found between the audit grade and the received audit activity grade (r=0.156) and the final course grade (r=0.227). Regardless of this result, the results similarities from the student's audit to the result from the auditor reflected the necessity for including more problem-solving/work-based challenges in engineering courses, as all the associated competencies and skills can be refined and reinforced with subsequent challenges, as the denoted by the competency level obtained for competencies STA0302 Management of food processes and STA0204 Management of food safety systems, were only 80 and, 40% of the students respectively achieved an outstanding level of competency. This also corresponds with the auditors' opinions, who stated that she gathered all her experience over 8 years, in which she fulfilled quality assurance and food safety management roles and finished different courses, certifications, and diplomas, as she mentioned, "*Almost all my work experience has been in quality assurance and food safety, I also have experience with R&D, yet in all those positions I had to implement and develop good manufacturing practices, personnel training, ISO 22000 schemes, global market actions, and HACCP from the start. I have also been audited for certification purposes and have taken many HACCP courses, particularly a course from which I was*

certified as a HACCP alliance gold seal auditor". Therefore, many practice skills are usually mastered through work experience, however, promoting auditing activities in real work environments with the enrichment of continuous education courses during higher education studies is a good starting point for maturing a set of employability skills in engineering students.

The Training Partner validated the final instrument and answered an audit service feedback form, as shown in Table 3. From his role as manager and employer, the training partner denoted her satisfaction with the audit service and the efficiency of exploring all the company's areas. In addition, the Training Partner rated the students with the highest grade in terms of professionalism. This course implementation was relevant from the industrial perspective and helped the Training Partner identify undetected needs and requirements, which led to changes and corrective actions. This is a medullar point for developing employability skills, as the students could propose applicable solutions to a real-life problem without an aged experience or the fulfillment of their engineering studies. Moreover, the Training Partner recommended this activity to other companies and considered this audit exercise as an essential platform for reinforcing auditing skills in students who are close to graduate.

Table 3. Translated questions and answers received from the Training Partner through RedJade.

Question	Possible Answers	Training Partner's Answer
Q1. What is your name?	NA	ND
Q2. Regarding the audit service, how do you grade it?	1) Very unsatisfied	Very satisfied
Q3. Regarding the audit deepness, how would you grade its efficiency?	2) Unsatisfied 3) Neutral (Neither satisfied nor unsatisfied) 4) Satisfied 5) Very satisfied	Very satisfied
Q4. What was the professionalism level that the service brought in?	1) Not at all professional 2) Not very professional 3) Neither professional nor unprofessional 4) Professional 5) Very professional	Very professional
Q5. Do you consider it relevant to repeat this audit activity?	1)Yes	Yes
Q6. Did you identify any need that had not been detected?	2) No	Yes
Q7. Have you made any changes or corrective actions based on the established observations?	3) Not sure	Yes
Q8. Have you observed any improvement in the general company's operation?	1) Totally disagree 2) Disagree	Agree
Q9. As a user, would you recommend this academic activity to other companies?	3) Indifferent 4) Agree 5) Totally agree	Totally agree
Q10. How relevant do you consider this academic activity for reinforcing skills related to quality assurance and food safety auditing in students before graduating?	1) Not at all important 2) Less important	Totally important

	3) Indifferent 4) Important 5) Totally important	

NA: Not applicable, ND: Not disclosed

Summarize the key outcomes of your study. If these are not available by abstract submission, summarize the anticipated results or outcomes.

CONCLUSIONS

The application of an on-site auditing exercise was relevant for developing auditing skills in the students, which granted similar results to those from an experienced auditor. This validated the efficiency of the exercise for successfully solving real-life problems commonly faced when the students graduate and begin working. This activity was enriched by integrating continuous education materials, which denoted the need to include these contents in higher education curricula to solidify those skills and increase the students' employability. The aforementioned was supported by the opinion of the audited company, which indicated the need for the students to practice these skills before their insertion into the industry. For those reasons, we proposed that continuous education should start at higher education institutions so that professionals can become more competitive and ready to resolve different industrial challenges.

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Playing with Progress: Gamification as a Catalyst for Meeting Industry 5.0 Needs

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1. CONTEXT

The industrial sector has undergone a significant transformation over time to meet the demands of society and the market. Currently, the industry is centered around a model that emphasizes collaboration between humans and machines, customization, sustainability, agility, and resilience, which is referred to as Industry 5.0 (Huang et al., 2022). This shift is a departure from the previous model that solely focused on automating and digitalizing processes (Slavic et al., 2024). For this reason, educational strategies must help develop them. Therefore, gamification could help develop these competencies so that individuals and organizations can adapt and function in this new context.

KEYWORDS: gamification, industry 5.0, innovation, collaboration, human.

2. PURPOSE OR GOAL

The present paper aims to explain how gamification can act as a catalyst between industrial education 5.0 and the development of requisite competencies. It emphasizes the key gamified aspects that must be considered to promote innovation, commitment, and human-machine collaboration in this new industrial stage. The study sheds light on the potential of gamification in driving the development of competencies necessary to thrive in the industry 5.0 ecosystem.

3. APPROACH

This study focuses on the utilization of gamification, which is an innovative educational approach that has shown promising results in facilitating effective learning. The study analyzes successful practical experiences to identify and present the key components of gamification that can promote the acquisition of skills, knowledge, and values necessary for this new industrial era.

4. ACTUAL OR ANTICIPATED OUTCOMES

Industry 5.0 requires implementing innovative strategies to foster skill development that caters to the needs and interests of the rapidly evolving societal context. In this regard, gamification has emerged as a vital tool, along with other approaches, to achieve this objective. The effective utilization of these key elements holds the potential to enable organizations to adapt to the

changing landscape of the industrial world successfully. From the review, these elements are the following:

1. **The game and its elements**

Gamification, a technique that uses game elements to encourage engagement and participation, has gained popularity in various industries due to its potential to enhance curiosity and productivity among employees. Studies have shown that gamification techniques, such as leaderboards, badges, and levels, can stimulate interest in challenging tasks and improve team performance (Girdauskiene, Ciplyte, and Navickas 2022; Oke et al. 2023). However, for gamification to be effective, certain factors must be considered, such as the clear communication of game rules and mechanics, incentives and rewards for users, a secure and reliable technological infrastructure, real-time progress tracking and monitoring, and feedback that allows users to evaluate their performance (Aliu et al. 2023). These elements must be carefully implemented and monitored to ensure that they align with the organization's goals and values while providing a positive and engaging experience for users.

2. **Relationship of the task with the elements of the game**

According to Girdauskiene, Ciplyte, and Navickas (2022), gamification can be a valuable tool for enhancing employees' understanding of their job responsibilities and the impact of their contributions to their organization. Additionally, Jedel, Palmquist, and Gillberg (2021) suggest that gamification can facilitate the acquisition of transversal and disciplinary competencies by providing simulated tasks in daily operational environments. In this way, gamification offers a structured approach for employees to learn and develop their skills and knowledge, ultimately leading to improved job performance and organizational outcomes.

3. **Opportunities**

Gamification has emerged as an effective tool for developing new learning ecosystems that can keep up with the changing trends, approaches, and requirements within industries. It offers a means to transform tedious and monotonous tasks into engaging, meaningful, and challenging activities, thereby fostering motivation, cooperation, trust, teamwork, employee commitment, and job satisfaction (Girdauskiene, Ciplyte, and Navickas, 2022; Jacob et al., 2022). Moreover, it provides a platform for granting incentives and recognition that promote organizational belonging. This approach leverages cognitive biases to steer desirable behaviors, utilizing persuasive messages and attractive task framing. As such, the gamification strategy can motivate employees, reduce operating costs, and improve coordination among them, leading to organizational success in the Industry 5.0 era (Leite et al., 2023; Torresan and Hinterhuber, 2023).

5. CONCLUSION

Gamification has emerged as a promising approach to integrate human-centric Industry 5.0 objectives with innovative engagement in industrial systems. The integration of game dynamics in industrial settings is believed to foster enhanced productivity, creativity, and worker satisfaction, key factors for the symbiosis of advanced technologies and human ingenuity that defines the Industry 5.0 paradigm. This approach offers a novel way to promote workforce engagement and motivation while facilitating the adoption of Industry 5.0 technologies. It should be more studied and used to understand all its benefits within the industry.

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Shaping Tomorrow's STEM Women Leaders: A Comparative Analysis of Current Educational Trends and Future Insights

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CONTEXT

Fostering women's leadership in Science, Technology, Engineering, and Mathematics (STEM) fields is essential for advancing gender equity and harnessing creative and innovative potential in these domains. Research has indicated that women's participation in STEM yields numerous advantages, ranging from augmentation in the diversity of perspectives and solutions to enhancing the quality of STEM-related products and services (Dusen and Nissen 2020). Continuing education is crucial to stay updated with advancements and scientific knowledge and develop the necessary skills and expertise to effectively lead and navigate the STEM field. This type of education allows women to adapt to new methodologies and practices and make informed decisions that drive innovation and success. This study analyzed and compared current educational trends and future insights, utilizing the Shaping Tomorrow platform, which uses three foresight tools: Horizon Scanning, Scenario Planning, and Strategic Intelligence. A comprehensive literature review was also conducted to benchmark these findings against current methods widely discussed in academic articles.

KEYWORDS: Women leaders in STEM, gender equality, gender perspective, gender issues in STEM education, educational trends, forward-looking research, higher education, educational innovation.

PURPOSE

This research seeks to define the foresight-driven trends suggested by the Shaping Tomorrow platform and conduct a thorough analysis by comparing them with current educational trends. By employing a robust analytical framework, the research aims to contribute insights into the evolution of continuing education and its potential impact on fostering leadership capabilities among women in STEM disciplines. Finally, the study seeks to illuminate potential gaps and opportunities through this comparative lens, offering a valuable perspective for educators, policymakers, and stakeholders invested in advancing gender equity and leadership diversity in STEM.

APPROACH

This study analyzed and compared current educational trends and future insights, utilizing the Shaping Tomorrow platform, which uses three foresight tools: Horizon Scanning, Scenario Planning, and Strategic Intelligence. A comprehensive literature review was also conducted to benchmark these findings against current methods widely discussed in academic articles. The investigation was carried out using digital methods.

OUTCOMES

Twelve relevant emerging technologies were identified and categorized based on their characteristics, providing a structured framework for understanding their diverse applications. These technologies have been examined based on Impact, Timeframe Projection, and Technology Readiness Level (TRL). Also, seven actionable educational strategies have been identified and categorized according to their priority. The Timeframe delimits the period in which it is necessary to perform these actions. Additionally, five distinct future scenarios envision transformative changes in fostering gender diversity and empowerment. Finally,

a diverse range of initiatives based on literature aimed at cultivating women leaders in the STEM field were identified and categorized according to their distinctive characteristics.

CONCLUSIONS

Utilizing technologies such as augmented reality, virtual reality, blockchain, artificial intelligence, gamification, the Internet of Things (IoT), and cloud computing can serve as a differentiator in developing leadership competencies for women in STEM. According to the research, these technologies, which fall within the range of TRL 5 to 7, could significantly impact within three years. With the increasing demand for diversity and gender inclusion in STEM fields, various investigations have recognized the need to utilize innovative technologies to develop women leaders in those areas (Gallindo, Cruz, and Moreira 2021; Kersanszki and Nadai 2020).

EdTech platforms, Learning Management Systems, and Adaptive Learning Platforms could be useful technologies for the development of leadership competencies in women. According to the results of the analysis using Horizon Scanning and Strategic Intelligence, these technologies are projected to have a high impact within a timeframe of 1 to 2 years.

Online learning platforms offer adaptable and easily accessible educational opportunities for women in STEM disciplines (Baker et al. 2022). These platforms deliver courses, tutorials, and resources tailored to enhance STEM skills and knowledge. Additionally, they create a supportive online community, allowing women to connect with and learn from other women in STEM, cultivating a sense of belonging and empowerment (Shafipour et al. 2018).

Mentorship can be very helpful in developing leadership competencies in women in STEM. The analysis revealed that mentorships should be highly prioritized within the next three years. By pairing women with experienced mentors who have already excelled in their STEM careers, mentees can learn valuable insights, strategies, and best practices for navigating the male-dominated STEM fields; it provides guidance, support, and opportunities for skill development and networking (Chang et al. 2021; Sutherland, Mohammadi, and Harris 2022).

The continuous evolution of STEM fields emphasizes the imperative for research in emerging topics and technologies. Forward-looking research is indispensable for preparing the next generation of women leaders with competencies aligned with future demands. Through Continuing Education, individuals can acquire the necessary skills and knowledge to contribute effectively to these advancements, fostering gender equity and empowering leaders to navigate the challenges and opportunities of the ever-evolving STEM landscape. In conclusion, the intersection of innovative methodologies, transformative technologies, strategic planning, mentorship initiatives, and forward-looking research is paramount in shaping a future where women in STEM succeed and lead competently and confidently.

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The Anxiety of Engineering Faculty in Relationship to Their Required Continuing Education

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CONTEXT

Continuing Education Programs, which incorporate disciplinary and pedagogical knowledge (Lima Ferreira & Bertotti, 2016), play a crucial role in the development and integration of teachers. They also enable teachers to stay updated in their discipline (Saline, 1983). This, in turn, can positively impact their well-being (Hammond, 2004). The potential impact of this study's findings on the well-being of engineering faculty is significant and should not be underestimated.

During the pandemic, the need to promote Continuing Education Programs arose (Donitsa-Schmidt & Ramot, 2020). This situation implied an exponential increase in teacher training and well-being courses. This increment brought an additional demand for teachers' time.

This study, conducted during the COVID-19 pandemic at a northeastern private university in Mexico, is relevant. This university's Continuing Education teaching training program aims to strengthen and develop knowledge, skills, and competencies in educational models and pedagogical competencies. The program's axes, institutional culture, teaching practice, human dignity, and health and welfare, are crucial in the current context (Panqueva and Hernán 2019). Mandatory courses address priority institutional needs, whereas optional training courses teachers may take according to their personal and professional interests.

KEYWORDS: Continuing Education, Anxiety, Engineering, Teacher's Training, Faculty Development, Higher Education, Educational Innovation.

PURPOSE

Anxiety is one of the most common mental disorders in Mexico and globally (Neri Vázquez et al., 2023), and its incidence has increased significantly during the pandemic (Gaitán-Rossi et al., 2021). Studies conducted on university instructors identified several risk factors associated with anxiety disorders, such as age, gender, marital status, discipline taught, and workload, among others (Ma et al., 2022). The risk of experiencing burnout and anxiety has increased during the pandemic (Balaguera and Ortiz González, 2021). Thus, the present research aims to study the relationship between anxiety and the Continuing Education Program.

APPROACH

This quantitative research has a non-experimental design, cross-sectional type, and correlational scope. 289 engineering instructors (108 women and 181 men) participated by responding anonymously and voluntarily to a survey.

A Spanish version of the Generalized Anxiety Scale (Spitzer et al. 2006), called GAD-7, was applied. It consisted of five Likert-type items, with scores ranging from 0 to 3. The maximum score (15) indicated a severe degree of anxiety.

OUTCOMES

For data analysis, the statistical software JASP version 0.18.3 was used, and tests of central tendency, Pearson correlation, t-student test for independent samples, and ANOVA for independent samples were performed. The statistical significance value $p \leq .050$ was used.

The level of anxiety reported by the participants was low (m=2.7, SD=2.82). No statistically significant differences were found by gender (t=1.56, p=.119, d=.18). However, there is a statistically significant difference among academic grades concerning the degree of anxiety (F=5.24, p=.006, η^2=.033). Teachers with bachelor's grades tend to express slightly more anxiety.

No significant correlations were found between anxiety and age (r= -.06, p=.271, z= -.06), anxiety and gender (r= -.08, p=.119, z= -.08), nor anxiety with teaching experience (r= -.02, p=.645, z= -.02).

Regarding the hours dedicated to the continuing education program, the sample attended an average of 20.06 hours (SD=19.96, min=1.0, max=121.0). On the other hand, anxiety correlates positively with the hours spent on continuing education courses (r=.21, p=.001, z=.22).

CONCLUSIONS

The results show that teachers presented a low level of anxiety, and no significant differences were found between age groups, gender, and teaching experience. These findings are consistent with a study by Ma et al. (2022), who conducted a meta-analysis on anxiety in teachers, where most studies suggest that anxiety levels tend to be low in higher education. However, this study highlights that women tend to experience higher levels of anxiety, a disparity that was not reflected in our results. This discrepancy could be attributed to the flexibility of certain courses and to institutional efforts to promote equality of roles and tasks, providing equitable tools to the entire educational community. On the other hand, teachers who have a bachelor's grade tend to express more anxiety, and this could be attributed to a sense of the security and emotional tools that the experience and age bring.

Also, the results indicate that as the dedicated training time increases, the perception of anxiety among teachers increases. However, it is crucial to emphasize that these levels are minimal and do not indicate the presence of an anxiety disorder per se. They may reflect the usual adaptation process to new techniques, methodologies, or educational technologies in these programs. This phenomenon is commonly observed in teachers in the field of engineering who seek to improve their skills and knowledge (Sastre Merino et al. 2021). Therefore, the activities proposed as part of continuing education must be aligned with existing needs. That is, any course, workshop, or training should have a clear purpose for implementation. This will help avoid overloading teachers and promote interest and perceived value in the courses, with the desired impact in the classroom.

One of the main limitations of this study is the lack of continuous measurement of anxiety levels during the implementation of continuing education programs. In addition, it would be important to evaluate the levels of personal and job satisfaction, as they could provide insights into why the population shows low anxiety levels (Cantón Mayo & Téllez Martínez, 2016). This would provide greater clarity in the results and facilitate the orientation of the courses.

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The Engineers for Europe Project (E4E)

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CONTEXT

In today's ever-evolving economy and society, the field of engineering occupies a central position, with engineers playing a crucial role in shaping virtually every product and service we rely on in our daily lives. Their contributions are indispensable for fostering innovation, driving economic growth, and addressing critical health and environmental concerns. However, the engineering profession is confronting significant shortages of engineers and skills mismatches in Europe, particularly in transversal competencies that are increasingly valued by employers.

The current focus on technical skills in engineering has widened the gap in transversal competencies. Employers now value a blend of multidisciplinary skills, emphasizing the need for a more unified approach to engineering education and training. However, the disconnect between higher education, vocational training and industry only adds to the profession's challenges. Recognizing the limitations of university education in providing all necessary skills, Continuous Professional Development (CPD) and Lifelong Learning (LLL) have emerged as indispensable.

KEYWORDS: Engineering, education, transversal skills, industry, Lifelong Learning, micro-credentials Skills Council

PURPOSE OR GOAL

In response to these pressing challenges, the Engineers for Europe (E4E) initiative has been launched, under the Erasmus+ program. The primary objective of E4E is to empower engineers with new competencies, focusing on key areas such as digitalization, sustainability, resilience, and entrepreneurial skills. Moreover, E4E aims to bridge the growing gap between educational institutions and industry while integrating essential EU competence frameworks such as GreenComp, DigComp, EntreComp, and LifeComp.

For this purpose, the “European Engineering Skills Council” was established to foster a more coordinated and influential European voice for engineers. The Council evaluates the European engineering education while actively engaging with stakeholders. It prioritizes key areas such as digitalization, sustainability, entrepreneurship, and societal impact. Additionally, it addresses other pertinent topics including attracting youth to the profession (STEM), professional ethics, employability, remuneration and future trends. The Council serves as a platform for dialogue and action, aiming to shape the future of engineering in Europe.

APPROACH

Informed by primary surveys from the E4E partners and secondary literature research, the “Draft European Engineering Skills Strategy” has translated these insights into actionable plans structured around three pillars.

Firstly, the strategy entails a comprehensive assessment of the current landscape, with a specific focus on non-technical dimensions such as digital literacy, environmental consciousness, and resilience. Secondly, it anticipates future demands through scenario planning, ensuring that the engineering profession remains adaptable to evolving needs. Lastly, the strategy commits to ongoing monitoring and evaluation to assess progress and evolution, enabling timely adjustments to the Skills Strategy, of which three versions will be developed over the course of the three years in the project.

ACTUAL OR ANTICIPATED OUTCOMES

In the ongoing phase of the E4E project, we are actively developing micro-credentials in collaboration with our partners of academic institutions, vocational education and training (VET) providers, as well as industry stakeholders. These micro-credentials are geared by our research findings and aligned with the objectives described in the first Skills Strategy.

In the second half of the E4E project, a Skills Passport will be created alongside the Training modules based on the four EU competence frameworks (GreenComp, DigComp, EntreComp and LifeComp), which will then go through an extensive testing phase. At the end of the project, the Skills Council will ideally evolve into an independent body and become a think-tank for the engineering education and profession, engaging in innovative actions through partnership with stakeholders wishing to build a coherent community. The Skills Council could in the future serve as a platform for Higher Education Institutions (HEIs), Vocational Education and Training (VET) and industry representatives to streamline their respective needs.

As the project is still in progress and the final product cannot be presented yet, we will elaborate on two best practices incorporated in the Skills Strategy. These examples highlight the importance of adopting a contemporary approach to engineering education and strengthening the connection with the industry, just like the Engineers for Europe project.

Firstly, ENGINEERS EUROPE's participation in the EuroTeQ Presidential Strategy Forum exemplifies a proactive effort to reshape engineering education. The EuroTeQ Engineering University, comprising six leading European institutions situated in innovation hubs, aims to revolutionize engineering education by fostering responsible value co-creation in technology. Central to this initiative is the EuroTeQ Collider, which provides students with the opportunity to collaborate with industry partners on real-world challenges, thereby enhancing their competencies through challenge-based learning experiences aligned with the United Nations Sustainable Development Goals (SDGs).

Secondly, the Faculty of Engineering FEUP at the University of Porto, in collaboration with the Ordem dos Engenheiros – two of the E4E partners - have implemented a Transversal & Transferable Skills Program. This program aims to cultivate a diverse skill set encompassing areas such as Arts, Social Sciences, and Humanities, alongside technical expertise. Through a range of courses and initiatives, including active learning approaches and industry collaborations, FEUP prioritizes the development of soft skills essential for success in the engineering profession.

CONCLUSIONS

In conclusion, the contemporary engineering landscape necessitates a holistic approach that encompasses both technical proficiency and transversal competencies. Initiatives like E4E and exemplary practices underscore the commitment to equipping engineers with the multifaceted skill set required to navigate complex challenges and contribute meaningfully to societal advancement and sustainable development.

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The Role of HEI in Upskilling and Reskilling: Marble-Tech

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CONTEXT

It is a fact that currently there is a gap between the skills that employers seek in their employees and the skills that job seekers possess. Nowadays in the labor market, it is more frequent that many employers complain about the skills gap by stating about difficulty to find qualified personnel who own the necessary skill sets to be qualified for the available positions. The technical paper prepared by ILO and OECD (2023) for G20 Summit also elaborated the complexity of skills mismatches, their high presence even in G20 countries and the need for diverse policy measures to address different types of skill challenges.

According to the European Commission (2022), more than 75 percent of enterprises in the EU state that it is tough to find staff with the right skills. Furthermore, the demand for the high skilled staff to be occupied in different sectors is growing every year. It was also cited that Eurostat figures demonstrated that just 37 percent of adults regularly attend lifelong learning activities. However, the Member States of the EU have already provided their national commitment that at least 60% of individuals should participate in training each year, in order to promote lifelong learning to achieve the EU 2030 social targets. Within the European Year of Skills, the Commission also highlighted the importance of ensuring that skills should be applicable to the demands of the labor market especially for the green and digital transition. Furthermore, the recent OECD Skills report (2023) emphasizes the need to respond to emerging labor market needs and efforts to promote inclusive green and digital transition. In this paper, a specific sector (marble sector) in different European countries was analyzed for the skills match and training requirements, and accordingly upskilling and reskilling methodology and education tools are discussed.

KEYWORDS: Labor market, lifelong learning, marble sector, MOOC, re/up-skilling, skills gap

PURPOSE OR GOAL

In order to respond to the demand of the labor market and increasing concern about digitalization and green transition, HEI and VET providers must constantly analyze the sectorial developments and keep the dialogue with the different actors in the labor market for a better understanding and response. This communication link is of high importance for the identification of the skills required for the sectors and thus the areas that need to be improved by means of education and training are revealed.

Bogazici University Lifelong Learning Center (BULLC) gives utmost attention to overcome skills mismatch by collaborating with different stakeholders in the labor market, in order to identify skills that need to be improved. Accordingly, BULLC develops and implements new professional development programs in different sectors. Thanks to the Erasmus+ projects of the EU which create added value by internalization and peer learning such as the Marble-Tech project in which BULLC functions as a project partner and University of Pisa as a project coordinator. The project objectives include first identifying the skills needed by the marble sector especially concerning sustainability and technology, and then developing new methodologies and learning tools based on MOOCs for re-engineering the training process targeted to the current and potential executives in the marble sector.

APPROACH

Within the scope of the Marble-Tech project, detailed desk research and field research were conducted, in order to analyze the current situation of skills requirement in the project countries, namely Greece, Italy, Portugal, Spain and Turkiye. Initially, literature review was done including academic resources and public reports to collect the most up-to-date information on the state of the art and the needs of the marble sector (needs and trends in the sector, best available practices, available education programs, etc.). In the next phase at field research it was aimed to identify both the transversal and professional skills that the marble manager/executives need to possess in order to increase the competitiveness of the marble sector. The survey was focused on issues of digital and technological knowledge, quality and environmental management besides other skills i.e. management, entrepreneurial and social skills. In the later stage, the outcomes of the researches were verified by means of stakeholders' workshops. Eventually, it is targeted to enhance the skills of the professionals in the marble industry through a cross-disciplinary online training program, combining both professional and transversal skills.

ACTUAL OR ANTICIPATED OUTCOMES

Based on desk research and field research studies, the national reports were prepared and published as the e-guideline of inputs for stakeholders of the marble sector. In particular, the desk research allowed to reach the following results:

- analysis of the current situation of the marble sector in the project partner countries;
- analysis of the new skills for the future marble sector based on the European sectoral reports (including partners' countries).

The field research in each country carried out through the questionnaire surveys led to:

- define the recent training needs for current/potential managers of marble industries;
- collect inputs from the experts and VET professionals on the more requested skills and competences for those executives/managers.

Questionnaires from field research, completed by 210 participants including managers, experts, technicians, artisans, and other stakeholders, have provided valuable perspectives about the training needs of the marble industry. Additionally, desk research has offered quantitative and qualitative insights into relevant training and study programs in the marble industry. In order to validate the outcomes of the desk research and field research studies to ensure that the e-guideline reflects the most up-to-date reality of the marble sector, the feedback and insights were collected from external stakeholders who had expertise in the marble industry such as experts, VET providers, sectoral bodies.

The validated results of both field and desk research are providing information about the training needs of stakeholders. Depending on the research outcomes, for the critical impact on the skills gap at the sector four modules of the education program are determined, namely Environmental and Legal Aspects, Business Management and Marketing, Quality and Safety, and Technology.

CONCLUSIONS

The ornamental marble sector plays a crucial role in supplying various industries and contributes significantly by improving quality of life and promoting culture and history. The European marble sector is experiencing significant changes, which require technological competencies, green and digital skills besides specialized technical skills. This shift is in line with evolving European trends such as digitalization and green transition in qualification and training, and highlighting the importance of sector-specific skills. The Marble-Tech aims to engage and educate stakeholders in the marble industry by providing comprehensive knowledge and skill sets related to marble processing, applications, and industry-specific innovations.

It is believed that the managers may serve as the key conduits for disseminating knowledge, strategies, and best practices, ultimately setting the tone for the organizational culture for a sustainable future.

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The Silent Language: Decoding Non-Verbal Communication in Industry 5.0

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CONTEXT

Industry 5.0 working conditions are characterized by a greater use of technologies and a decrease in interpersonal interactions, however, a demand for soft skills persists in the labor market, as these remain irreplaceable, such is the case of communication skills (Poláková et al., 2023). The preferred method of communication by employees, regardless of existing conditions, is face-to-face, mainly because it provides an open space for interpersonal interaction, allowing participants to observe nonverbal attitudes and perceive emotions and feelings (Țigan et al., 2022). Virtual work represents a psychologically different experience than face-to-face work, virtual teams are characterized by shorter social exchanges and a lack of para verbal and nonverbal communication, which increases the complexity of collaboration, affecting workers' mental health, leadership, and therefore productivity of organizations (Destouet, et al., 2023; Kralj & Aralica, 2023, Mutha & Srivastava, 2023).

KEY WORDS: Non-verbal communication, Manifestations, Capacities, Industry 5.0.

PURPOSE OR GOAL

The above scenario makes evident the need to improve nonverbal communication practices in technology-mediated work environments, and if we add the inherent immersion of Industry 5.0, Artificial Intelligence (AI), and human-robot interactions, this need becomes urgent.

The objective of this article is to identify the manifestations and capacities of non-verbal communication in technology-based work environments, in order to strengthen the communication skills required in Industry 5.0 from the educational field.

APPROACH

The study was carried out through a Systematic Literature Review in the Scopus and Web of Science (WoS) databases with search words based on the key concepts "Industry", "nonverbal communication", "manifestations" and "capacities". The filtering process was performed according to the Preferred Report Elements for Systematic Reviews and Meta-analyses (PRISMA) designed for exhaustive analyses (Rethlefsen & Page, 2021). As inclusion criteria, it was considered that the study was related to the topic, provided new evidence on the relationship between nonverbal communication manifestations and skills in the industry, and that it was written in English or Spanish; As an exclusion, the study was not related to the topic, did not provide new evidence on these relationships, or was in a language other than those referred to. Of 80 articles obtained (46 in Scopus and 34 in WoS) 24 duplicates were eliminated, 4 in different languages, and 15 whose contribution was not for this research. Finally, 38 were kept for analysis.

ACTUAL OR ANTICIPATED OUTCOMES

Various manifestations of nonverbal communication play a crucial role in technology-mediated work environments. The most common (Fareen & Al, 2018; Seo, 2018; Visconti et al., 2023) are videos, audio, calls, text, avatars, virtual and digital content, the level of resolution, speed, and pictograms, digital annotations (Anton, et al., 2018), accents and tone of voice, length of speech, appearance as a face shape, geometry, expressive lines (Yun, Hongpeng, 2022), outfit, grooming, emotional facial expressions (anger, sadness, happiness, surprise, disgust, fear, neutrality) that are measured by facial cues (eyes, eyebrows, nose, cheekbones, mouth, chin), gaze as eye contact, eye movements, body movements such as crossing arms, tilt and twist of the torso and head, orientation of the body and face, hand and finger gestures (Sheikholeslami et al., 2017), physical proximity, kinesic courtesy cues (Alves et al., 2022), and social behavior (Denizci, 2019).

In Industry 5.0, where the symbiosis between humans and machines is essential, developing the following In Industry 5.0, where the symbiosis between humans and machines is essential, developing the following capabilities linked to non-verbal communication, several authors (Denizci, 2019; Fareen & Al, 2018; Seo, 2018; Visconti et al., 2023) agree on promoting the following: mastery of social and business etiquette, self-regulating tone and length of speech, conveying confidence, understanding different accents of the language, communication with employees at any level of hierarchy, emotional expressiveness, verbal and graphic interpretation of content, sharing knowledge interactively and visually (Anton, et al., 2018), brief and concise writing, demonstrating active participation, recognizing and responding to robotic cues: kinesic courtesy cues and reducing signs of response hesitation (Alves et al., 2022), and hand gestures (Sheikholeslami et al., 2017).

CONCLUSIONS

Nonverbal communication holds a pivotal role in the communication processes within the industry. The significance of this study is to offer a framework for interpreting or assertively expressing intentions and emotions in technology-mediated work environments. This is crucial for the timely education of individuals currently preparing to engage in Industry 5.0.

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Tracing a Decade's Trends on Skills (2011-2023): A Review of Four Organizations

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CONTEXT

The report analyses skills and competencies trends from UNESCO, ILO, OECD, and the EU over a decade, focusing on digital transition, distance learning, skills mismatches, workplace skills utilization, and youth employability. The European Commission and OECD launched the Future of Education and Skills 2030 project, focusing on developing competencies and understanding students' needs for knowledge, skills, attitudes, and values to improve quality of life and promote well-being.

KEYWORDS: competency, skill, global competence, digital technologies

PURPOSE OR GOAL

The purposes of the study are as follows:

(1) To study a decade's trends in skills and competencies between the four organizations

(2) To find out about skills and competencies in a global context between 2011-2013

(3) To compare the skills and competencies between the four organizations

The following are the research questions of the study:

(1) What are the current trends of skills and competencies between the four organizations?

(2) What are the skills and competencies in a global context between 2011 and 2013?

(3) What are the challenges facing the skills and competencies in a global context?

(4) What are the similarities and differences of the four organizations between 2011 and 2023?

APPROACH

In this study, a literature survey method was applied, and data were collected from books, reports, survey results, journals, and periodicals published by the EU, ILO, UNESCO, and OECD between 2011 and 2023.

ACTUAL OR ANTICIPATED OUTCOMES

Table 1. Compare the skills and competencies between the four organizations

Year	EU	ILO	UNESCO	OECD
2011	Competences for Lifelong Learning	Youth employability skills	SDGs with a focus on environmental and sustainability competencies	The Skills Strategy
2012	Vocational education and training (VET)	Youth employability skills	Youth and skills: putting education to work: foundation, transferable, and technical and vocational skills	Strong literacy skills during their primary and secondary education are considered vulnerable
2013	Education and Training (ET2020). Investing in Education and Training,	Enhance young people's employability.	Literacy and literate environments	Survey of Adult Skills (PIAAC): key information-processing competencies.
2014	Managing Competencies in Public Administrations (MC-PA)3.	The skills are categorized under four broad headings: learning to learn, communication, teamwork and problem solving.	'Ensure equitable and inclusive quality education and lifelong learning for all by 2030'. early childhood care and education; basic education; adult and youth literacy; skills for work and life; skills for global citizenship and sustainable development; teachers; and financing of education.	Professional education and training
2015	Key competencies for lifelong learning	Environmental competency	Transversal competencies (TVCs) used in the six domains: critical and innovative thinking; interpersonal skills, intrapersonal skills, global citizenship,	Social and emotional skills

			media and information literacy and others.	
2016	Vocational education and training (VET) and lifelong learning Digital Skills and Jobs Coalition	Skills-oriented learning throughout life Learning in workplaces: developing 'hard' & 'soft' skills	Skills for work and life: learning and upskilling in workplaces Adult education	Three key information-processing skills: literacy, numeracy and problem solving in technology rich environments.
2017	New Skills Agenda	Skills utilisation in workplace	Digital skills	Digital competence
2018	Competence-oriented education, training and learning	Recognition of prior learning (RPL): acknowledges that learning outcomes	Representing skills, competencies, and qualifications: social and technological mobilization in identifying, recognizing, documenting, and certifying skills	Global competence
2019	Core Competencies	Skills, competencies	Representing skills, competencies, and qualifications: social and technological mobilization in identifying, recognizing, documenting, and certifying skills	Digital technology
2020	Workforce Renewal and Skills Strategy 2020–2025	Employer organization involvement in skills governance arrangements in the context of rapid increase of	'Three I' approach: identification, integration, and implementation	Three transformative competencies – taking responsibility, reconciling tensions and dilemmas, and creating new value

		skills needs of enterprises.		
2021	Digital and technological advancement	Lessons for TVET during COVID-19: identification of challenges and opportunities	Transforming TVET	Digital capabilities Digital government leadership skills:
2022	The green and digital transitions	Digital skills	Skills for work and life Skills to learn, work, and live (individuals) Skills to transition towards sustainable development (economies) Skills for inclusive & resilient societies (societal)	GreenComp approach sees education and sustainability as connected at all levels within disciplines and subjects through the competences embedded within the curriculum.
2023	The green and digital transitions	Skills anticipation	Competency-based education	policy advice and analysis on skill development, their effective use in the economy and society, and strengthening skills system governance.

CONCLUSIONS

From 2011 to 2023, education has undergone a transformative journey, with initiatives and strategies reflecting the evolving needs of a rapidly changing global landscape. The initial years focused on lifelong learning and youth employability, while the mid-decade saw a shift towards vocational education and training. The New Skills Agenda recognized digital skills as essential building blocks of education, emphasizing the need for adaptation in a digitalized world.

The COVID-19 pandemic led to a shift to online and remote learning, highlighting the adaptability of educational systems and the transformative power of digital capabilities. The GreenComp approach emphasized the intertwining of education and sustainability, paving the way for competency-based education and skills anticipation. Governments worldwide are grappling with the financial crisis and the knowledge economy, emphasizing the need for a skilled workforce for all young people.

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Upskilling and Reskilling for Sustainable Entrepreneurship: Green KAIT

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CONTEXT

The imperative to upskill and reskill the workforce for a sustainable future underscores the need for targeted education, training, and development initiatives to meet the demands of a rapidly evolving and sustainable economy. This concept recognizes that the nature of work is changing, influenced by factors such as technological advancements, environmental concerns, and shifting industry landscapes. To address these changes, FH JOANNEUM has implemented an upskilling and reskilling programme called Green KAIT (Kapfenberger Accelerator and Incubator for Green IT), aimed at ensuring that pupils, students, and entrepreneurs, especially women, remain relevant, adaptable, and capable of contributing to a more sustainable and resilient future.

KEYWORDS: upskill and reskill, workforce, green deal, sustainable entrepreneurship

PURPOSE OR GOAL

In designing the Green KAIT program, several research questions needed to be addressed to ensure its effectiveness and sustainability:

What are the key challenges faced by participants in integrating sustainability into their startup ideas, and how can these challenges be effectively addressed within the Green KAIT program?

How does the involvement of women entrepreneurs in the Green KAIT program impact the sustainability and success of their startups, and what strategies can be implemented to further encourage their participation?

What are the strengths, weaknesses, opportunities, and threats (SWOT) associated with the implementation of the Green KAIT program, and how can these factors inform future iterations and improvements?

APPROACH

The research methodology involved a qualitative approach using a SWOT analysis to evaluate the strengths, weaknesses, opportunities, and threats associated with the implementation of the Green KAIT program. This analysis involved gathering qualitative data mainly through focus group interviews and an online survey with program initiators, stakeholders, and an Austrian funding agency (n=10) to explore participants' perceptions of the program's objectives, challenges, and overall effectiveness in addressing the demands of a rapidly evolving and sustainable economy. The aim was to provide valuable insights into the effectiveness and sustainability of the Green KAIT program, as well as recommendations for iterations to maximize its impact on workforce upskilling and sustainable entrepreneurship.

ACTUAL OR ANTICIPATED OUTCOMES

By means of thematic analysis, common themes, patterns, and correlations in terms of SWOT emerged. Strengths were identified by examining the positive attributes and successful aspects of the program, such as its ability to foster innovation, support sustainable business models, and engage diverse participants. Weaknesses were outlined by assessing areas where the program may fall short or encounter challenges. Opportunities were identified by exploring potential avenues for growth, improvement, and expansion of the program, such as new partnership opportunities, emerging market trends, or innovative approaches to sustainability. Threats mainly revolved around external factors that may pose risks or obstacles to the program's success, such as economic downturns, regulatory changes, or competing initiatives.

Based on the SWOT analysis, the program's three pillars were established. Firstly, the Startup Combo offers participants the opportunity to combine their sustainable or social idea with a green business plan, aligned with the EU's Green Deal objectives. Secondly, Green Incubee provides consulting services covering technical, legal, economic, and social aspects as well as technological issues. Thirdly, the green Startup Support facilitates awareness-raising, advice, and networking for those interested in founding a company, green startups, and green incubators.

In achieving this the Green KAIT programme needs to operate on a regional level first to enhance the ecosystem for green start-ups including new partnerships and tapping into both university and non-university potential. Through the activation and stimulation of talents in the region, the programme seeks to foster self-employment and the establishment of companies specializing in areas relevant to the Green Deal. Additionally, Green KAIT focuses on strengthening existing "green" start-ups and supporting companies in their green transformation through collaboration or active spin-offs of start-ups, aligning with the EU's objectives. The initiative also emphasizes the expansion of existing initiatives and infrastructure to further support sustainable entrepreneurship. Furthermore, the programme aims to bolster competencies in start-ups, particularly in the field of "green technologies" and digitization, through closer cooperation within higher educational institutions. This comprehensive approach aims to drive innovation, sustainability, and economic growth in the region and beyond.

CONCLUSIONS

Creating, maintaining, and strengthening an ecosystem requires the contribution of as many people, institutions, and companies as possible. Achieving visibility, effectiveness and the desired sustainable transformation requires a holistic strategy. The Green Deal and the sustainability requirements of the EU and the United Nations (UN) are very comprehensive and clear. Hence, Green KAIT will deal with a variety of topics such as energy efficiency, environmentally friendly buildings/offices, renewable energy sources and waste reduction as well as air quality, healthy environments, and sustainable mobility. Digitalization and IT solutions are about to support these initiatives as these topics needs to be addressed from an interdisciplinary viewpoint. In a broader sense, the development of environmentally friendly solutions includes the implementation of socially responsible business practices. The upskilling and reskilling programme of Green KAIT will lead to a long-term change in awareness and behaviour not only in Upper Styria but ultimately in all project regions of the Austrian funding agency.

Many initiatives worldwide focus on similar objectives, emphasizing the need for education, entrepreneurship support, and interdisciplinary collaboration to address sustainability challenges. The Green KAIT programme's emphasis on gender inclusivity, regional collaboration, and holistic strategies reflects contemporary best practices in sustainable development and entrepreneurship support.

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Who is solving the challenge? The use of ChatGPT in STEM Education

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CONTEXT

As of the conclusion of 2022, following the post-COVID-19 landscape, the emergence of Artificial Intelligence (AI) has collected significant attention and sparked discussions surrounding its utility and potential risks in educational settings. Notably, within AI advancements, the Conditional Generative Pre-Trained Transformer, ChatGPT, emerged as a sophisticated Natural Language Processing model trained on extensive datasets. This technological evolution will impact future workforce training, as ChatGPT's capabilities offer innovative solutions to understand and solve Industry 4.0's complex and ill-defined problems. Universities have witnessed noteworthy changes with the integration of ChatGPT, even by adapting academic integrity policies and exam formats to address potential student misuse. However, ChatGPT tools have not yet been appropriately studied for its implementation in Continuing Education (CE) environments. Recent reports about ChatGPT experiences at universities indicated that its replication in CE settings, particularly STEM subjects, could offer real-time explanations and illustrative examples, aiding future workers in entering the workforce seamlessly.
KEYWORDS: Higher Education, Challenge-based Learning, ChatGTP, AI, STEM, Educational Innovation

PURPOSE OR GOAL

This study investigates the impact of ChatGPT on the academic performance of undergraduate and graduate students participating in digital distance education courses, which are the basis of continuing education. ChatGPT stands for "Chat Generative Pre-Trained Transformer", a type of artificial intelligence model developed by OpenAI that has been widely accepted among students. However, it is not the only Generator to emerge from this artificial intelligence boom, and more and more programs are becoming available to the population; our educational institution has created TecGPT, a generator available to collaborators, teachers, and students of the University. ChatGPT-like generators are designed to understand and generate human-like text based on their input. They are often used in various natural language processing tasks, such as answering questions, generating text, or engaging in conversation. Our institution initiated a pilot program to evaluate several ChatGPT applications for suitability in educational settings. The Tec21 educational model has four fundamental pillars: 1) Inspiring Teachers, 2) Memorable Experience, 3) Flexibility, and 4) Challenge-based learning. Here we describe a study on solving challenges in STEM subjects of continuing distance education. Our main objective is that through activities using the different AIs, we can develop skills and make students aware of the ethical use of artificial intelligence tools.

APPROACH

Two massive continuing and distance education digital courses on "*Fundamentals of Biological Systems*" were studied. Both courses had 105 and 107 students each, making a large sample for our intended study. This subject belongs to the first third of the majors. The students of this subject come from many majors, not just STEM, which makes the study even more interesting.

Two challenges were designed, with the objectives of developing both transversal (soft) and disciplinary (hard) competencies. According to the Tec21 educational model, the teaching process must be founded on challenge-based learning.

CHALLENGE 1. Determine a solution to a biological challenge using ChatGPT and compare its result with personal research, thus raising students' awareness of the ethical use of text generators like ChatGPT.

CHALLENGE 2. Use of a Microbiota simulator to modify the "inputs" which in this case are nutrients that can modify environmental conditions and that will affect the well-being of the human host. Using this generator of environmental conditions, students understand that we are what we eat and that the intestinal microbiota is specific to everyone.

The challenges were designed with a satisfaction and opinion questionnaire, which allowed us to collect results on how novel and useful the experience of using artificial intelligence tools was in solving challenges.

ACTUAL OR ANTICIPATED OUTCOMES

The students used ChatGTP to solve CHALLENGE 1, and surprisingly, many of them already had knowledge of this text generator. The students did state that in many ways, the concepts expressed in ChatGTP differed a little from those found by traditional methods; in other cases, they questioned that the data was not completely updated and not as deep, and others questioned the databases or the information that powers ChatGTP, others used two different generators and observed significant differences.

In the case of CHALLENGE 2, the Microbiota simulator, the understanding of the constitution, the modification by environmental conditions, and the consequences of the alteration of the microbiota was decisive in the development of disciplinary competencies. The students highly appreciated the power, with the help of artificial intelligence, to objectively understand what the intestinal microbiota is, the importance and what it means for well-being.

CONCLUSIONS

Overall, ChatGPT has the potential to revolutionize the higher education process by providing personalized support, enhancing learning experiences, and improving access to educational resources. However, it is essential to recognize that while ChatGPT can complement traditional teaching methods, it is not a substitute for human instructors and mentors. The results detailed here are part of a larger study that evaluates the use of AI by students and educators. By employing a challenge-based learning approach, we explore the potential improvements that AI can bring to this teaching methodology. The evaluation methods, the exercises' design, and the students' opinions were recognized to exhaustively analyze the possibilities presented by using an AI tool like ChatGPT.

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Women in STEM: Leadership, Mentoring and Contributions to Continuing Education in Engineering

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CONTEXT

The underrepresentation of women in Science, Technology, Engineering, and Mathematics (STEM) fields is a persistent issue that limits diversity and hinders the full utilization of talent. Addressing these disparities requires concerted efforts to empower women and foster a more inclusive STEM community. One promising approach is through continuing education mentoring programs led by experienced women in STEM. The active participation of women with vast experience in STEM as mentors in mentoring programs is critical to inspiring, professionally developing, and guiding new generations of women in these disciplines. Research into mentorship indicates that, on average, women in their STEM employees are less likely to receive mentoring than men. Mentoring programs have been recognized as a beneficial strategy for reducing the underrepresentation of women in STEM and have consequently been established to attract and retain women in STEM fields (Campos et al, 2022; Saffie-Robertson 2020). This research provides valuable insights from women in managerial, teaching, research, and external professional roles in STEM, thus contributing to Continuing Engineering Education.

KEYWORDS: Academic mentoring program, continuing engineering education, female mentors, women in STEM, gender issues in STEM education, higher education, educational innovation.

PURPOSE

The main objective of this research is to explore the perspectives of female mentors in STEM fields and to analyze how their different roles contribute to continuing engineering education.

APPROACH

Nineteen semi-structured interviews were conducted with women in various roles in STEM, including management, teaching, research, and external professional positions. The interviews aimed to capture the diverse perspectives of these female mentors from their different roles in STEM areas. All interviews were video-recorded and transcribed for their analysis. Qualitative analysis techniques were employed to derive themes and insights from the interview data, highlighting the importance of female mentoring in fostering diversity and inclusion in STEM. This project has the approval of the Ethics Committee. All participants were 18 years old or older and signed a consent form to use their image, voice, and content.

OUTCOMES

The analysis revealed several key findings regarding the perspectives of female mentors in STEM. First, female mentors emphasized the importance of their roles in inspiring and guiding new generations of women in STEM disciplines. Their vast experience and insights are critical in supporting the professional development of future female engineers and scientists. Second, mentors recognized the value of collaboration and networking among women in STEM to address gender disparities and promote equity.

Third, the mentors highlighted the importance of a global and interdisciplinary approach to addressing complex challenges in STEM fields, advocating for interdisciplinary collaboration and knowledge sharing.

The findings of this research have several implications for continuing engineering education and efforts to promote diversity and inclusion in STEM. First, the perspectives of female mentors underscore the critical role of mentoring programs in supporting the advancement of underrepresented groups in STEM careers. By leveraging the experiences and expertise of female mentors, institutions can create more inclusive learning environments and opportunities for future female engineers and scientists. Second, the emphasis on collaboration and networking among women in STEM highlights the importance of community-building initiatives and support networks to address systemic barriers to diversity and inclusion. Finally, recognizing a global and interdisciplinary perspective emphasizes the need for a holistic approach to STEM education and research, fostering innovation and problem-solving across traditional boundaries.

CONCLUSIONS

Some works that show the importance of inquiring about perspectives considering roles are those of Ahad and Gunder 2017, who address the issues that women take on considering their roles when facing and negotiating in different spaces such as work and their careers, as well as work that addresses the role of women in dental education (Reed, Corry, and Liu 2012). The findings of this research have several implications for continuing engineering education and efforts to promote diversity and inclusion in STEM. The perspectives of female mentors underscore the critical role of mentoring programs in supporting the advancement of underrepresented groups in STEM careers. The value of mentoring is recognized (Dominguez, 2023; Torres-Ramos et al. 2021) viewing mentoring as a mutually advantageous partnership that offers mentees and mentors a range of benefits, extending from personal fulfillment to professional progression. By leveraging the experiences and expertise of female mentors, institutions can create more inclusive learning environments and opportunities for future female engineers and scientists. Also, the emphasis on collaboration and networking among women in STEM highlights the importance of community-building initiatives and support networks to address systemic barriers to diversity and inclusion (Stelter, Kupersmidt, and Stump 2021). Finally, recognizing a global and interdisciplinary perspective emphasizes the need for a holistic approach to STEM education and research, fostering innovation and problem-solving across traditional boundaries.

In conclusion, this paper has highlighted the diverse perspectives of female mentors in STEM and their contributions to continuing engineering education. By amplifying the voices of experienced women in STEM careers, this research aims to foster a more diverse and inclusive STEM community. The findings underscore the importance of mentorship, collaboration, and a global perspective in addressing the underrepresentation of minorities in STEM fields. Moving forward, it is imperative to implement the recommendations proposed in this paper to drive meaningful change and create a more equitable future for all individuals pursuing careers in science, technology, engineering, and mathematics.

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