Educational Administration: Theory and Practice
2024, 30(5), 5859-5867
ISSN: 2148-2403
https://kuey.net/

Research Article

Exploring Pedagogical Excellence In Higher Education For Industry 4.0 Skill Development

Mohini Pooja Huggahalli[1*], Dr. Divya Kirti Gupta[2]

[1*]Research scholar, GITAM School of Business, Hyderabad GITAM (Deemed to be University), Rudraram, Sangareddy District, Telangana,mhuggaha@gitam.in, poojahuggahalli@gmail.com,ORCIDiD,https://orcid.org/0009-0004-0037-8537
[2]Associate Professor and HoD-HRM GITAM School of Business, Hyderabad, GITAM (Deemed to be University) Rudraram, Sangareddy District, Telangana dgupta@gitam.edu.

Citation: Mohini Pooja Huggahalli, Dr. Divya Kirti Gupta, (2024), Exploring Pedagogical Excellence In Higher Education For Industry 4.0 Skill Development, *Educational Administration: Theory and Practice*, *30*(5), 5859-5867
Doi: 10.53555/kuey.v30i5.3874

ARTICLE INFO

ABSTRACT

This study focuses on the pedagogical strategy for imparting the necessary skills for Industry 4.0. The assessment of the predetermined goals is being studied using the exploratory research methodology. The study has considered a practical sample technique for gathering primary data using the created questionnaire. After applying regression weight analysis and exploratory factor analysis, the study recognized project-based learning, technological integration, an interdisciplinary approach, and industry partnerships as realistic techniques. Teachers and administrators should concentrate on learning outcomes, alignment of teaching methods, continuous evaluation and improvement, regular training and development, student engagement, fostering a culture of innovation, and creating a supportive environment to implement these approaches in higher education institutions successfully. Faculty may give students more meaningful and engaging learning experiences that will improve their performance in class and help them succeed in their future careers by implementing the approaches and strategies that have been identified.

Keywords:HEI pedagogies, Industry 4.0, Higher education, Students, faculty

Introduction

Industry 4.0 (I4.0) describes the fourth industrial revolution, where the integration of digital technologies is transforming the manufacturing and production industries. Digital literacy, problem-solving, critical thinking, and adaptability are among the new competencies needed for this change (Jagannathan et al., 2019 & Mustata et al., 2022). Teachers are investigating several educational approaches that can transfer I4.0 skills to students in an efficient manner. Several indicators can be used to assess the efficacy of teaching approaches in the context of I4.0 skills. It is imperative that the methodology support active learning, whereby learners engage in practical tasks and are motivated to cooperate with their peers (Jagannathan et al., 2019). The system's capacity to foster the critical thinking and problem-solving abilities necessary for success in the digital age is a further cause for concern.

The term "pedagogical approaches" describes the range of strategies and techniques educators and teachers employ to instruct and encourage learning in a classroom or other educational setting. These methods consider the subject matter being taught, the age and background of the student, as well as the learning goals. They are founded on several learning theories. There are many different pedagogical approaches, such as technique-based education, project-based learning, flipped classrooms, inquiry-based learning, collaborative learning, experiential learning, and many others. Combination of practical teaching pedagogies along with scientific research help in imparting industry required knowledge, skills, and abilities in students (Simeunovic et al., 2022).

Each system has advantages and disadvantages and can be used to achieve various learning goals and circumstances. Pedagogical approaches aim for a learning environment that is effective, interesting, and suited to the requirements and learning preferences of the students. Teachers may ensure that students achieve the essential learning outcomes and reach their maximum potential by selecting the most successful pedagogical approaches and tailoring them to students' needs. Moreover, teachers' skills should also be honed according to the updated industrial requirements. This can help them understand the incorporating

and amending the curricula as per I4.0 requirements. Project-based, problem-based, and inquiry-based learning are popular pedagogical strategies that effectively promote I4.0 capabilities (Sekulic et al., 2022). Students participating in project-based learning work on assignments that call for them to apply their knowledge to real-world problems.

In problem-based learning, open-ended questions are utilized to stimulate pupils' critical thinking and problem-solving skills. An emphasis of inquiry-based learning is on student-centred, self-directed learning via investigation and discovery. Apart from these tactics, the overall application of technology integration and simulation tools can also enhance the effectiveness of educational approaches in teaching I4.0 competencies. Simulations and augmented reality are two immersive learning environments that are vital for I4.0, that students can use to get the virtual picture of the actual situation. This helps them to improive their critical and design thinking skills and sharpen their technical competencies (Vilalta-Perdomo et al., 2022).

Technology imbibing curricula and simulation tool integration can also augment to the critical problem-solving skills of students at HEI level. These instructional strategies prepare students for the I4.0 digital era (Vilalta-Perdomo et al., 2022). Faculty must take the initiative to choose courses whose learning objectives are in line with industry requirements. They must be able to create student-centric learning environment for developing leadership skills in students at HEIs (Mourtzis et al., 2022). Engineering education can be effectively taught through active learning, improving student learning outcomes and competencies (García-Peñalvo & Alarcón, 2019). They conducted a study to investigate the relationship between student achievement and skill development in engineering education and active learning. The quasi-experimental design of the study includes pre-and post-test assessments. Undergraduate students studying mechanics in mechanical engineering participated in the study. The study discovered that in engineering education, active learning has a substantial impact on students' performance and skill development. The study revealed that active learning has a substantial impact on student achievement and the development of skills in engineering education.

Review of literature

The paper attempts to critically analyze and synthesize existing literature on knowing the need for inculcating I4.0 related skills in students by higher educations. The study attempts to present the literature review in a tabular format to facilitate comprehension.

Table 1 The tabular format of Literature Reviews

Author(s)	Year	Focus	Key Findings	Conclusion
Monaco & Martin	2007	Characteristics of millennial students and suggestions for adapting teaching strategies to meet their needs better	Incorporating technology and interactive teaching methods can improve engagement and learning outcomes. Creating a positive learning environment that fosters collaboration, respect, and open communication is also essential.	Practical recommendations for educators to better understand and serve the millennial student population.
Beichner	2008	SCALE-UP project and its impact on learning	SCALE-UP creates a collaborative and interactive learning experience emphasizing problem-solving, inquiry-based learning, and group work.	The SCALE-UP project can raise participation levels and encourage in-depth study.
Pegrum et al.	(2013).	Use of iPads to facilitate preservice teachers' learning	iPad helped the preservice teachers engage with content, collaborate with peers, and develop their digital literacy skills.	iPads can be an effective way to facilitate learning and help build digital literacy skills in preservice teachers.
Slomanson, W. R.	(2014).	Flipped classroom experiment in a law school environment	Increased student engagement and improved learning outcomes with the use of recorded video lectures before class and interactive discussions and exercises during class	The flipped classroom paradigm can result in better student learning outcomes and more effective use of class time.
Krajcik & Shin	(2014).	Project-based learning and its benefits	Effective project-based learning includes real-world problems, collaboration, and inquiry-based learning.	Project-based learning can help students better understand the content and essential skills for the 21st century.
Burke	2015	Active learning classrooms and the Scale-Up classroom design	The scale-Up classroom model is adequate for teaching law in extensive enrollment courses.	Scale-Up classroom design is a flexible tool for law teachers to engage students and facilitate learning.
Kong and Song	2015	A personalized learning hub for higher education students using BYOD technology	The personalized learning hub, focusing on reflective engagement, improved students' learning outcomes and motivation.	Personalized learning hubs can provide a platform for students to engage in reflective learning and collaborative activities, leading to improved learning outcomes and motivation.
Bower et al.	(2015).	Design and implementation factors in blended synchronous learning	The success of integrated synchronous learning environments depends on appropriate technology selection, activity and assessment design, and support and guidance.	Careful planning and implementation are crucial for the success of blended synchronous learning environments.
Soneral and Wyse	(2017).	Effectiveness of high-tech vs. low-tech AL	Regardless of the technology level, active learning	Technology level does not impact the effectiveness of active learning.

			environments can effectively promote student learning.	
Burke & Fedorek	(2017).	Flipped classroom vs. traditional and online	Flipping the classroom can promote higher engagement and satisfaction levels than traditional and online classes.	Flipping the classroom can enhance student engagement and satisfaction.
Schwieger and Ladwig	2018	Modifying instruction to match Gen Z students' expectations in the classroom	Incorporate technology into teaching methods, provide experiential learning opportunities, and use collaborative learning techniques.	Educators can effectively engage Gen Z learners by adapting their teaching methods accordingly.
Stiefvater	2018	Project-based blended learning in CTE programs	Project-based learning can boost student engagement and enhance learning results in blended learning settings.	Project-based blended learning can be effective in CTE programs.
Ongbali, Afolalu, and Udo	2019	Factors Contributing to the youth unemployment problem in Nigeria	Several factors contribute to the youth unemployment problem, including population growth, lack of infrastructure, inadequate education and training, corruption, and unfavorable government policies.	It is essential to address these underlying factors comprehensively to effectively tackle Nigeria's youth unemployment problem.
Beyza Himmetoglu, Damla Aydug, Coskun Bayrak	2020	Characteristics of Education 4.0	The necessity of integrating technology into education to implement Education 4.0. Need to research the curriculum and readiness levels of the Turkish Education System.	Research is required to ensure the integration of education with technology for Education 4.0.
Yawson, D. E., & Yamoah, F. A.	2020	Factors influencing e-learning satisfaction among students from different generational cohorts	Course content, instructional design, and technology were the most critical factors influencing e-learning satisfaction. Different generational cohorts had different levels of satisfaction with these factors.	Understanding the factors that influence e-learning satisfaction among different generational cohorts can help institutions design and deliver e-learning courses that are more effective and engaging for all students.
Cabrita et al.	(2020).	Preparing for Education 4.0 and required skills	Creativity, critical thinking, problem-solving, communication, teamwork, and digital literacy are necessary for education 4.0.	Educational institutions need to adapt to meet these changing requirements.
Felicia Veronica Banciul and Anamaria Ioana Feier	2021	Interdisciplinary competencies in engineering courses	Need for collaboration between universities and industry—practical experience is required to transition from theory to practice. Soft skills are equally important as technical knowledge.	The learning system needs to be revised to include training in soft skills. Future research is necessary to establish the required software skills and how they can be achieved.
Shohel et al.	2021	Challenges and Opportunities of blended teaching and learning in higher education	The benefits of blended learning include increased flexibility and improved student engagement. Challenges include the need for specialized training and support for faculty and students and the potential for an increased workload.	Higher education institutions can successfully implement blended learning programs with proper training and support for faculty and students.
Kgwete and Malatji	2021	Importance of project-based learning in developing critical thinking, problem-solving, and collaboration skills	The ability to collaborate, think critically, and solve problems are all talents that may be developed through project-based learning. Effective implementation involves clear goals, assessment, and support for students.	Students' ability to collaborate, think critically, and solve problems can all be improved through project-based learning.
Border et al.	(2021).	Co-producing e-learning resources in blended learning	Co-producing e-learning resources with students can improve engagement and provide a more student-centered learning experience.	Co-producing e-learning resources with students is a practical approach to blended learning.
Eliseo Vilalta Perdomo, Rosario Michel-Villarreal and Ricardo Thierry-Aguilera	2022	Developing working skills for the future of work	CBL intervention increases students' understanding of I4.0 issues and provides an environment for soft-skills training—a blueprint for implementing CBL in the Operations Management curricula.	CBL intervention can be replicated in business schools in the UK, but findings might not be directly generalized to other contexts or disciplines.
Chigbu & Nekhwevha	2022	The collaborative interaction between human and robotic workers in South Africa's automotive industry	The integration of robotics has improved efficiency, productivity, and safety. However, some workers expressed concerns about job security and the impact of technology on their job satisfaction.	Further research is necessary to understand how integrating robotics, and human workers can achieve optimal outcomes for workers and employers.
Forster et al.	2022	Pre-class video watching in flipped classrooms	Pre-class video watching can enhance student learning and knowledge retention in flipped classrooms.	Pre-class video watching is a practical approach for enhancing learning in flipped classrooms.

Bianca Ifeoma Chigbu, Viwe Ngwevu, Avela Jojo	2023	New pedagogies of teaching and learning in HEIs	The most efficient, long-lasting, student-centered pedagogy is integrated teaching and learning, such as the flipped classroom, SCALE-UP, blended teaching, and learning. Collaboration between all elements of the learning ecosystem is necessary.	Transgressive, innovative, transformative, varied, and inclusive teaching and learning with the I4.0, HE4.0, and W4.0 in mind are necessary for effective blended teaching and learning and stable student-centered academic output.

RESEARCH GAP

It can be inferred from the literature that integrating technology and interactive teaching methods can improve engagement and learning outcomes. Creating a positive learning environment that fosters collaboration, respect, and open communication is also essential. The SCALE-UP project can improve student engagement and promote deep learning. Project-based learning can help students better understand the content and crucial skills for the 21st century. Personalized learning hubs can provide a platform for students to engage in reflective learning and collaborative activities, leading to improved learning outcomes and motivation. Flipping the classroom can enhance student engagement and satisfaction. Regardless of the technology level, active learning environments n effectively promote student learning.
Creativity, critical thinking, problem-solving, communication, teamwork, and digital literacy are necessary for education 4.0. Soft skills are equally important as technical knowledge. HEIs can successfully implement blended learning programs with proper training and support for faculty and students. Based on the literature, it has been identified that teaching I4.0-related skills requires a pedagogical approach that emphasizes hands-on learning, problem-solving, and the use of technology.
Based on the above literature survey, fewer studies have focused on the skills deficit of the students in the context of I4.0. Therefore, the present study attempts to fill the research gap with the proposed title of "Exploring Effective Pedagogical Strategies for Industry 4.0 Skill Development in Higher Education".

RESEARCH QUESTIONS

Building upon the existing literature, this study addresses the research gap by formulating the following research questions.
1. What pedagogical approaches are used to teach I4.0-related skills?
2. What strategies can be identified for effectively utilizing pedagogical approaches in higher education institutions?

The base for the parameters:

Based on the literature survey, the following variables are considered to explain the pedagogical approach in teaching I4.0-related skills.

Table 2 Literature Support for Pedagogical Approach in Teaching I4.0 Related Skills

Project-based learning	Hanafi, A., & Ahmad, N. (2020), Ozer, A., & Gürel, E. (2018), Chen, C. H., Chen, Y. H., & Huang, Y. M. (2016)
Technology integration	An, Y. J., & Reigeluth, C. M. (2018), Mishra, P., & Koehler, M. J. (2006), Linn, M. C., Davis, E. A., & Bell, P. (2004)
Interdisciplinary learning	Barajas, M., & Owen, H. (2019),
Active learning	S. Akpinar and H. M. Cakir (2017). P. B. Lister, L. K. Geiger, and J. K. Goodwin (2015). K. R. Konduri, E. S. Kim, and S. S. Kang (2021)
Industry partnerships	J. C. Ziegler, C. M. Kim, and A. H. Blattner (2017),C. M. Young, L. M. Lewis, and R. J. Bertram (2017)

Source: Compiled by the authors

OBJECTIVE OF THE STUDY

1. To know the pedagogical approach in teaching I4.0-related skills.
2. To identify the strategies for effectively utilizing pedagogical approaches in HEIs.

RESEARCH METHODOLOGY

The present study has adopted the exploratory and qualitative approach to examine the I4.0-related skills that should be fostered in engineering and management students for the I4.0.

Sampling Method:

Study Area:

A structured questionnaire was used in the study to obtain primary data from the professors (respondents) using a convenience sample technique. Without conducting any more investigation, convenience sampling

uses the first primary data source available. To put it another way, this sampling method entails locating participants wherever they are found, which the most convenient location is usually (Marshall, 1996).

Sample Size:
Responses are collected from 120 faculty working in engineering and management institutions.
Sampling Unit:
The study has considered faculty working in NAAC and NBA-accredited engineering and business schools present in the Hyderabad region of Telangana state.
Source of Data:
The present study has considered the primary data through the drafted questionnaire to examine proposed objectives.
Questionnaire: The questionnaire consists of two broader segments, which focus on identifying relevant skills needed for I4.0 and the cost-effectiveness of pedagogical approaches in HEIs. The opinions are collected through the five-point Likert scale from the respondents.
The statistical tools used in the study were using SPSS Statistics software. The tools used in the study are Neural Networking and Exploratory Factor Analysis.
Regression analysis can be used to examine the relationship between one or more predictor variables (e.g., Pedagogical approach) and an outcome variable (e.g., student performance). This can help identify the most critical factors contributing to student success and understanding the Pedagogical approach.

Exploratory Factor Analysis:
EFA (exploratory factor analysis) is a statistical technique used to determine the underlying structure of many variables. This method extracts high-loading factors from the variables that impact the most dependent variable. This method crunches the data and outputs high-loaded variables through the component matrix. This analysis was done using the SPSS Statistics Software.

Tabulation of Data Analysis
Objective 1: To know the pedagogical approach to teaching I4.0-related skills.

Table 3 Model summary

Model	R	R Square	Adjusted R Square	Std. error of the Estimate
1	.898	.806	.798	.45729
a. Predictors: (Constant), Industry partnerships, Project-based learning, Interdisciplinary learning, Active Learning, Technology Integration				

Source: Compiled through the primary data

The table represents the model summary in which the r-square of the model is observed to be more than recommended level (0.806 >0.60), implying the model is a strong fit. The standard error of the estimate is observed to be low.

Table 4 ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	98.353	5	19.671	94.064	.000[b]
	Residual	23.630	113	.209		
	Total	121.983	118			
a. Dependent Variable: Student Skills						
b. Predictors: (Constant), Industry partnerships, Project-based learning, Interdisciplinary learning, Active Learning, Technology Integration						

Source: Compiled through the primary data

The table depicts the ANOVA of pedagogical approach variables. Here, the f-statistic of the estimates is 94.064, more significant than the critical value, and the p-value is less than 0.05, indicating that the estimates are effective at the 5 percent level.

Table 5 Coefficients Concerning the Pedagogical Approach

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.301	.179		-1.681	.096
	Project-based learning	.265	.058	.265	4.579	.000
	Technology integration	.310	.065	.303	4.737	.000
	Interdisciplinary learning	.207	.052	.212	3.955	.000
	Active learning	.122	.050	.125	2.416	.017
	Industry partnerships	.204	.046	.229	4.487	.000
a. Dependent Variable: Student Skill						

Source: Compiled through the primary data

The regression weight in the table shows the logical method used to teach skills related to I4.0. The results show that project-based learning and technology integration significantly positively impact student performance, respectively, with scores of 0.303 and 0.265. This implies that technology integration has given educators new opportunities to engage students in more meaningful and interactive ways and has allowed students to play a more active role in their learning.

It notes that interdisciplinary and industry partnerships have also been found to have a significant impact on student performance, suggesting that a multidisciplinary approach to education helps students develop a more holistic and comprehensive understanding of a topic or issue by tying together various subject areas and notes that by collaborating with business professionals, students can see how what they are learning in the classroom is applied in the real world, which can be beneficial.

This does not imply that active learning does not affect student performance; instead, active learning encourages students to think critically, solve problems, ask questions, and participate in discussions and activities. Active learning was found to have a low impact (0.125) compared to other pedagogical approaches. The p-value indicates that the alternative hypothesis is accepted, i.e., pedagogical approaches impact student performance.

Objective 2: To identify strategies for the effective utilization of pedagogical approaches in Higher Education Institutions

Table 6 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.741
Bartlett's Test of Sphericity	Approx. Chi-Square	625.102
	Df	45
	Sig.	.000

Source: Compiled through the primary data

The table represents the KMO and Bartlett's Test to measure sampling adequacy; the KMO calculated value is 0.741, which is more significant than 0.05, indicating adequate sample adequacy. Bartlett's test of Sphericity, the p-value is less than 0.05, meaning the sample considered is significant at a 5 % level.

Table 7 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.868	38.678	38.678	3.868	38.678	38.678
2	2.273	22.733	61.410	2.273	22.733	61.410
3	.911	9.111	70.522			
4	.882	8.819	79.341			
5	.675	6.754	86.095			
6	.493	4.930	91.024			
7	.318	3.176	94.201			
8	.299	2.994	97.195			
9	.159	1.588	98.783			
10	.122	1.217	100.000			

Source: Compiled through the primary data

The table represents the variance explained; component 2 is extracted from 10, in which component 1 has the eigenvalue of 3.868, which can explain the variance of 38.678. Component 2 has an eigenvalue of 2.27, which can explain the variance of 22.733. Together, the first two components explain 61.41% of the total variance.

Table 8 Factor Analysis concerning effective utilization of pedagogical approaches

	Component	
	1	2
Develop clear learning outcomes.		0.633
Align teaching methods with learning outcomes.		0.636
Provide training and support for faculty.		0.608
Encourage collaboration and teamwork.		0.325
Use assessment to measure the effectiveness.		0.588
Continuously evaluate and improve	0.799	
Offer regular training and development	0.802	
Engage students	0.788	
Foster a culture of innovation	0.743	
Establish a supportive environment	0.696	

Source: Compiled through the primary data

Table 8 shows the results of an exploratory factor analysis for strategies for effectively utilizing pedagogical approaches in higher education institutions. The study extracted two components that accounted for much of the variance in the data. The first component has high loadings on developing clear learning outcomes, aligning teaching methods with learning outcomes, providing training and support for faculty, and using assessment to measure effectiveness. The second component has high loadings on continuously evaluating and improving strategies, offering regular training and development, engaging students, fostering a culture of innovation, and establishing a supportive environment. Encouraging collaboration and teamwork could have loaded more on both components.

It observes that two key elements influence the effective utilization of pedagogical approaches in higher education institutions:

(1) a focus on learning outcomes and alignment of teaching methods and,

(2) a culture of continuous improvement and innovation. The results also suggest that providing training and support for faculty, using assessment to measure effectiveness, and establishing a supportive environment are essential strategies for achieving these components.

Result and discussion

The findings from the analysis of the regression weight and the exploratory factor analysis suggest that specific pedagogical approaches are more effective than others in enhancing student performance and effectively utilizing pedagogical practices in higher education institutions. The results show that project-based learning, technology integration, interdisciplinary approach, and industry partnerships significantly impact student performance. These approaches offer students new opportunities to engage in meaningful and interactive ways, develop a more holistic understanding of the subject matter, and see how their learning is applied in the real world.

Exploratory factor analysis further reveals that effective utilization of pedagogical approaches in higher education institutions requires a focus on learning outcomes, alignment of teaching methods, continuous evaluation and improvement, regular training and development, student engagement, fostering a culture of innovation, and establishing a supportive environment. Providing training and support for faculty and using assessment to measure effectiveness are also essential strategies for achieving these components. However, encouraging collaboration and teamwork may be less crucial in effectively utilizing pedagogical approaches.

Overall, these findings provide insights for educators and administrators on the most effective pedagogical approaches and strategies for enhancing student performance and achieving effective utilization of pedagogical approaches in higher education institutions. By adopting these approaches and techniques, educators can provide students with a more engaging and meaningful learning experience and better prepare them for the demands of the I4.0 era.

Conclusion of the study

The study focuses on the pedagogical approach to teaching I4.0 required skills. The study adopted an exploratory research approach for the examination of framed objectives. The study collected the primary data with the convenient sampling method. The study applied the regression weight analysis and exploratory factor analysis to suggest that specific pedagogical approaches enhance student performance and effectively utilize pedagogical practices in higher education institutions. Project-based learning, technology integration, interdisciplinary approach, and industry partnerships are all found to have a significant positive impact on student performance.

Moreover, effective use of pedagogical approaches in HEIs requires a focus on learning outcomes, alignment of teaching methods, continuous evaluation and improvement, regular training and development, student engagement, fostering a culture of innovation, and establishing a supportive environment. Providing training and support for faculty and using assessment to measure effectiveness are also essential strategies for achieving these components. On the other hand, encouraging collaboration and teamwork may be less significant in effectively utilizing pedagogical approaches.

These findings give educators and administrators valuable insights into the most effective pedagogical approaches and strategies for enhancing student performance and preparing them for the I4.0 era. By adopting these approaches and techniques, educators can provide students with more engaging and meaningful learning experiences, leading to better performance and success in their future careers.

Reference

1. Akpinar S. and Cakir H. M. (2017). - "The effect of active learning on student success and skills acquisition in engineering education."

2. An, Y. J., & Reigeluth, C. M. (2018). Creating technology-enhanced, learner-centered classrooms: K-12 teachers' beliefs, perceptions, barriers, and support needs. Journal of Educational Computing Research, 56(5), 633-663.
3. Barajas, M., & Owen, H. (2019). Interdisciplinary learning in the 21st century: An analysis of undergraduate curriculum. Journal of Curriculum and Teaching, 8(1), 75-89.
4. Beichner, R. J. (2008). The SCALE-UP Project: A student-centered, active learning environment for undergraduate programs. An invited White Paper for the National Academy of Sciences (Vols. 1–13). https://publish.illinois.edu/disruptivespaces/files/2014/07/SCALE-UP-Paper1.pdf.
5. Bell, P., Bricker, L. A., Reeve, S., & Zimmerman, H. T. (2006). From Telling to Understanding: Investigating seventh graders' conceptions of ecosystem dynamics. Journal of the Learning Sciences, 15(4), 403–440.
6. Border et al. (2021). Border, S., Woodward, C., Kurn, O., Birchall, C., Laurayne, H., Anbu, D., Taylor, C., & Hall, S. (2021). Working in creative partnership with students to Co-produce neuroanatomy e-learning resources in a new era of blended learning. Anatomical Sciences Education, 14, 417–425.
7. Bower, M., Dalgarno, B., Kennedy, G. E., Lee, M. J. W., & Kenney, J. (2015). Design and implementation factors in blended synchronous learning environments: Outcomes from a cross-case analysis. Computers & Education, pp. 86, 1–17. https://doi.org/10.1016/j.compedu.2015.03.006
8. Burke, 2015 on Scale-Up! Classroom design and use can facilitate learning. The Law Teacher, 49(2), 189–205.
9. Burke, A., & Fedorek, B. (2017). Does "flipping" promote engagement?: A comparison of a traditional, online, and flipped class. Active Learning in Higher Education, 18(1),11–24. https://doi.org/10.1177/1469787417693487
10. Cabrita, M. do R., Safari, H., Due˜nas, M., & del, P. M. (2020). Preparing for education 4.0: Skills facing economic, social, and environmental challenges. International Journal of Innovation, Management, and Technology, 11(1), 33–37. https://doi.org/10.18178/ijimt.2020.11.1.872
11. Chen, C. H., Chen, Y. H., & Huang, Y. M. (2016). Applying a project-based learning approach to the development of digital learning resources for children. Educational Technology & Society, 19(1), 45-57.
12. Chigbu & Nekhwevha, (2022). The collaborative work experience of robotics and human workers in the automobile industry in South Africa. African Journal of Science, Technology, Innovation, and Development, 14(1), 280–287.
13. Forster, M., Maur, A., Weiser, C., & Winkel, K. (2022). Pre-class video-watching fosters achievement and knowledge retention in a flipped classroom. Computers & Education, 179(1–14). https://doi.org/10.1016/j.compedu.2021.104399
14. García-Peñalvo, F. J., & Alarcón, H. (2019). Active Learning Experiences in Engineering Education. Engineering Education
15. Hanafi, A., & Ahmad, N. (2020). Industry partnership and project-based learning: Enhancing graduates' employability. Journal of Physics: Conference Series, 1529(1), 012072.
16. Jagannathan, S., Ra, S., & Maclean, R. (2019). Dominant recent trends impacting on jobs and labor markets-An Overview. International Journal of Training Research, 17(sup1), 1-11. https://doi.org/10.1080/14480220.2019.1641292
17. Kgwete & Malatji, 2021 Krajcik, J., & Shin, N. (2014). Project-based learning. Cambridge university press. https://doi.org/10.1017/CBO9781139519526.018
18. Konduri K. R., Kim E. S., and Kang S. S. (2021). - "Active learning approaches for interdisciplinary transportation education: a systematic literature review."
19. Kong & Song, 2015; Kong, S. C., & Song, Y. (2015). An experience of personalized learning hub initiative embedding BYOD for reflective engagement in higher education. Computers & Education, 88, 227–240. https://doi.org/10.1016/j.compedu.2015.06.003
20. Legal Education, 64(1), 93–102.
21. Linn, M. C., Davis, E. A., & Bell, P. (2004). Internet environments for science education. Lawrence Erlbaum Associates.
22. Lister P. B., Geiger L. K., and Goodwin J. K. (2015). - "Active learning in transportation engineering education: Industry-academic partnership for student engagement."
23. Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A new framework for teacher knowledge. Teachers College Record, 108(6), 1017-1054.
24. Monaco & Martin, (2007). The millennial student: A new generation of learners. Athletic Training Education Journal, 2(2), 42–46. https://doi.org/10.4085/1947-380x-2.2.42
25. Mourtzis, D., Panopoulos, N., & Angelopoulos, J. (2022). A hybrid teaching factory model towards personalized education 4.0. International Journal of Computer Integrated Manufacturing, 1-21. https://doi.org/10.1080/0951192X.2022.2145025
26. MUSTAȚĂ, I. C., Bacali, L., Bucur, M., CIUCEANU, R. M., Ioanid, A., & ŞTEFAN, A. (2022). The evolution of industry 4.0 and its potential impact on industrial engineering and management education. REVUE ROUMAINE DES SCIENCES TECHNIQUES—SÉRIE ÉLECTROTECHNIQUE ET ÉNERGÉTIQUE, 67(1), 73-78. https://journal.iem.pub.ro/rrst-ee/article/view/155/147

27. Ongbali et al., 2019 Ongbali, S. O., Afolalu, S. A., & Udo, M. O. (2019). Factors causing youth unemployment problem in Nigeria: A review. International Journal of Mechanical Engineering &Technology, 10(1), 1874–1879.
28. Ozer, A., & Gürel, E. (2018). The effect of project-based learning on students' academic achievement, attitude, and retention in science courses. Eurasia Journal of Mathematics, Science and Technology Education, 14(6), 2343-2352.
29. Pegrum et al., 2013 Pegrum, M., Howitt, C., & Striepe, M. (2013). Learning to take the tablet: How preservice teachers use iPads to facilitate their learning. Australasian Journal of Educational Technology, 29(4), 464–479.
30. Schwieger & Ladwig, 2018, Schwieger, D., & Ladwig, C. (2018). Reaching and retaining the next generation: Adapting to the expectations of gen Z in the classroom. Information Systems & Computing Academic Professioals, 16(3), 45–54.
31. Sekulic, M., Milosevic, M., Borojevic, S., Sredanovic, B., Aleksic, A., & Ilic, J. Production engineering curriculum in the context of Industry 4.0–current state of art and necessary changes in AP of Vojvodina and Republic of Srpska.
32. Shohel, M. M. C., Ashrafuzzaman, M., Islam, M. T., Shams, S., & Mahmud, A. (2021). Blended teaching and learning in higher education: Challenges and opportunities. In Handbook of research on developing a post-pandemic paradigm for virtual technologies in higher education. https://doi.org/10.4018/978-1-7998-6963-4.ch002
33. Simeunovic, V., Milic, S., & Pajrok, A. (2022). Higher Education in the Eyes of Economic Operators. Sustainability, 14(13), 7973.
34. Slomanson, W. R. (2014). Blended learning: A flipped classroom experiment. Journal of
35. Soneral and Wyse (2017), Soneral, P. A. G., & Wyse, S. A. (2017). A SCALE-UP mock-up : Comparison of student learning gains in high- and low-tech active-learning environments. CBE-life Sciences Education, 16(12), 1–15. https://doi.org/10.1187/cbe.16-07-0228
36. Stiefvater, E. (2018). Using project-based blended learning to engage career and technical education students. In Education Northwest. https://educationnorthwest. org/insights/using-project-based-blended-learning-engage-career-and-technical-education-students.
37. Vilalta-Perdomo, E., Michel-Villarreal, R., & Thierry-Aguilera, R. (2022). Integrating Industry 4.0 in Higher Education Using Challenge-Based Learning: An Intervention in Operations Management. Education Sciences, 12(10), 663.
38. Yawson, D. E., & Yamoah, F. A. (2020). Understanding satisfaction essentials of Elearning in higher education: A multi-generational cohort perspective. Heliyon, 6 (11), Article e05519. https://doi.org/10.1016/j.heliyon.2020.e05519
39. Young C. M., Lewis L. M., and Bertram (2017). - "Industry partnerships and active learning in a construction management curriculum".
40. Ziegler J. C., Kim C. M., and Blattner A. H. (2017). - "Industry partnerships and active learning: A partnership model to support undergraduate student success in sustainable engineering".