

Systematic Review on the Application of Metacognitive Strategies and the Benefits of Education 4.0 for Graduate Employability and Learning Sustainability

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DOI Link: <http://dx.doi.org/10.6007/IJARPED/v15-i1/27629>

Published Online: 17 February 2026

Abstract

The integration of metacognitive strategies and Education 4.0 is influential in enhancing employability and learning sustainability. However, there is a gap in systematic review papers focusing on this integration. Therefore, this review was conducted to explore this phenomenon by examining journal articles discussing challenges in employability and learning

sustainability, alongside the application of metacognitive strategies and Education 4.0 benefits. Following Cooper's and PRISMA guidelines, a systematic review was conducted across six major databases, screening articles published from 2017 until 2022, resulting in 49 studies in the final analysis. The findings revealed that the majority of studies were empirical, with diverse methodologies and a strong geographical focus on Asia. Four major themes were identified discussing the challenges in employability and barriers to learning sustainability as well as the application of metacognitive strategies and the benefits of Education 4.0. This review could significantly enhance educational outcomes by fostering learner engagement, benefit educators by improving teaching practices through tailored instruction, and address the skill gap by strengthening industry-academia ties, thus better preparing students for their future careers.

Keywords: Employability, Learning Sustainability, Metacognitive Strategies, Education 4.0, Systematic Review

Introduction

Employability is a critical goal for graduates as the primary purpose of higher education is to secure employment. While obtaining remarkable degrees and academic results is important, these alone do not guarantee employability (Abd Majid et al., 2020). Graduates must develop practical skills and soft skills to stand out to potential employers (Ma'dan et al., 2020). Soft skills such as teamwork, communication, critical thinking, and problem-solving, are often cultivated through extracurricular activities and hands-on learning experiences (Ma'dan et al., 2020). The Ministry of Education in Malaysia emphasises the importance of these skill sets which have been outlined as the graduate attributes in the Malaysia Education Blueprint 2015-2025 (Ministry of Education, 2015).

Achieving sustainable learning is vital for graduate employability, as it helps with independent learning and knowledge application throughout their careers. In a rapidly changing job market, graduates must be adaptable and capable of lifelong learning to remain competitive (Saleh & Abdul Wahab, 2025). Developing sustainable learning habits enables graduates to stay current with industrial trends and technological advancements, thereby enhancing their visibility and attractiveness to employers. Employers seek graduates who can independently sustain their learning and contribute meaningfully to their organisations (Saleh & Abdul Wahab, 2025).

Metacognitive strategies play a crucial role in enhancing employability and sustainable learning. These strategies, which involve planning, monitoring, and evaluating one's learning process, help graduates develop critical thinking and problem-solving skills essential for the workforce (Abd Latip et al., 2020; Anthonysamy, 2021; Philip, 2018; Yildiz, 2020). By fostering self-regulation and self-awareness, metacognitive strategies enable graduates to assess their knowledge and performance, identify areas for improvement, and adapt their learning approaches accordingly (Abd Latip et al., 2020; Anthonysamy, 2021; Philip, 2018; Yildiz, 2020). Recent studies prove that teaching students how to reflect and check their own progress is essential for thinking critically in digital spaces (Pereles-Pazos et al., 2024). However, as the job market moves toward Industry 4.0, experts do not yet agree on exactly which thinking skills graduates need to navigate a world where technology is constantly changing (Rosas-Quintero & Namuche-Maldonado, 2024). Furthermore, the rise of Artificial Intelligence (AI)

has made it even more important for students to take charge of their own learning, even if school policies are struggling to keep up (Khan et al., 2025).

Apart from metacognitive strategies, Education 4.0 also offers significant benefits for employability and sustainable learning through the integration of digital tools and technologies with teaching and learning. This educational paradigm equips 21st-century educators with the digital skills necessary to meet the needs of diverse learners and prepare them for the future job market (Ariza & Hernández, 2026). By leveraging technologies such as online learning platforms, virtual simulations, and collaborative tools, Education 4.0 enhances the learning experience and promotes the development of essential soft skills (Ariza & Hernández, 2026). Moreover, Education 4.0 supports the continuous and adaptable learning required for sustainable employability, enabling graduates to thrive in an ever-changing professional landscape.

Education 4.0 is influential in enhancing employability and learning sustainability. However, there is a gap in the literature in systematic review papers focusing on both the integration of metacognitive strategies and Education 4.0 to address the issues of employability and learning sustainability. This review is crucial to bridge the gap, provide educational outcomes by fostering learner engagement, benefit educators by improving teaching practices through tailored instruction, and address the skill gap by strengthening industry-academia ties, thus better preparing students for their future careers.

Research Questions

This review was conducted with the purpose to locate and examine journal articles and studies discussing the challenges in employability and learning sustainability as well as the application of metacognitive strategies and the benefits of Education 4.0 on employability and learning sustainability. This review was guided by these research questions:

1. What are the challenges in employability?
2. What are the challenges that students face to sustain learning?
3. How metacognitive strategies are applied in education?
4. What are the benefits of Education 4.0?

Methodology

The researchers carried out a systematic literature review following the recommendation of Cooper (1988). The synthesis of the literature involves several steps starting with formulating the research question, collecting data, evaluating data, analysing and interpreting data, and presenting and organising the results. Following the flow of the updated PRISMA, which is a short form for Preferred Reporting Items for Systematic reviews and Meta-Analyses for transparent and concise reporting method of the review process (Page et al., 2021).

The goal of data collection was to identify and analyse studies and journal articles addressing the challenges in graduate employability and learning sustainability, as well as the benefits of metacognitive strategies and Education 4.0 on these aspects. The search was conducted in December 2022 using a specific strategy.

Procedures

Figure 3 illustrates the procedures used in this review which include three stages: Identification, Screening and lastly, the included studies.

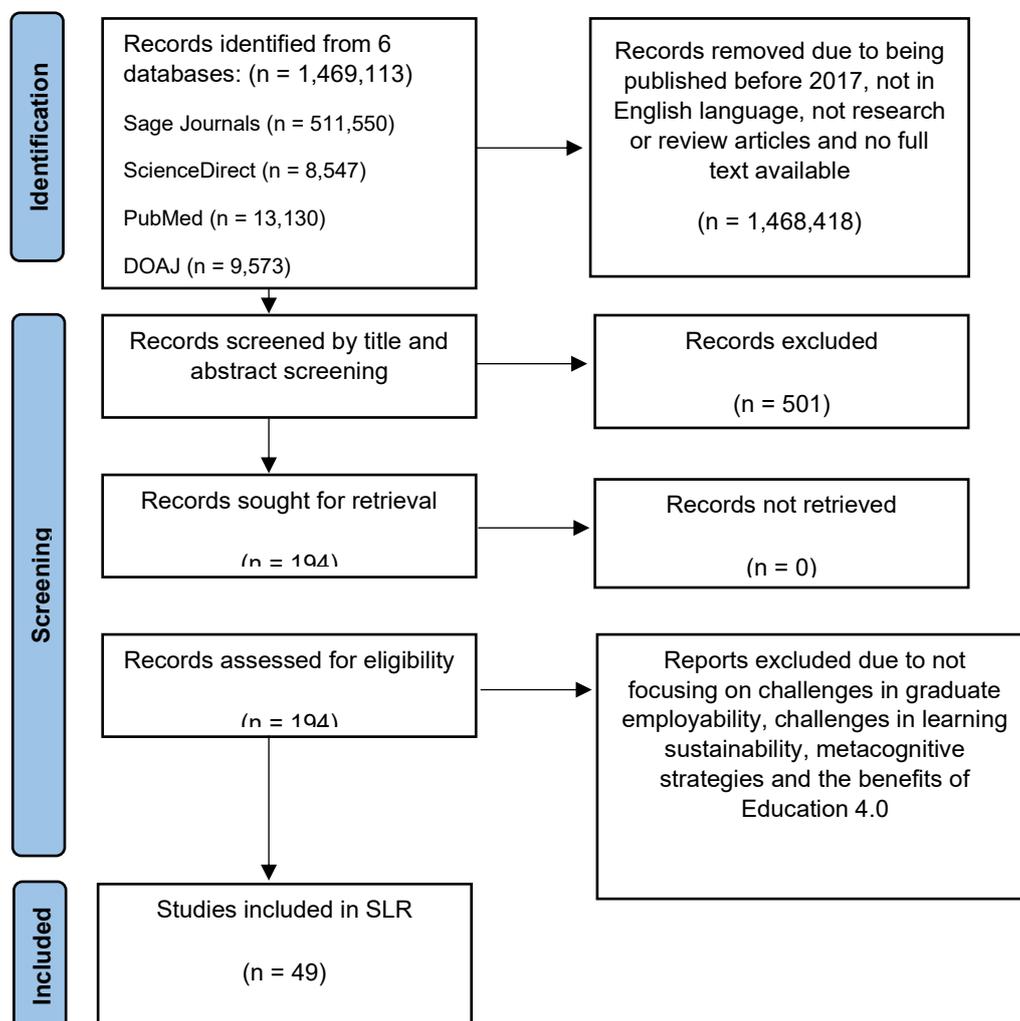


Figure 3: PRISMA flow diagram of the systematic literature process

Identification

The systematic literature review was conducted with a comprehensive search across six major databases: Sage Journals, ScienceDirect, PubMed, DOAJ, Emerald Insight, and Google Scholar. Using specific keywords tailored to each of the four research questions, a total of 1,469,113 records were initially identified.

Table 1

Keywords used in the search

RQ	Keywords Used
RQ1	“employability” OR “graduate employability” AND “challenges”
RQ2	“learning sustainability” OR “sustainable learning” AND “challenges”
RQ3	“metacognitive strategies” OR “metacognition”
RQ4	“Education 4.0” AND “benefits” OR “advantages” OR “impacts” OR “effects”

Following the initial results, the researchers used the "Advanced search" function to filter the records according to multiple inclusion criteria prior to the screening procedure. Only research and review articles published between 2017 and 2022 in the English language with full-text accessibility were included. Whereas, the rest were excluded. Overall, the total number of records identified during this stage was 695.

Screening

Following the identification stage, the screening process was conducted by screening the title and abstracts of the 695 records identified during the identification stage previously. The goal of the screening procedure was to determine whether or not the articles were relevant to the research questions. After screening the titles and abstracts, relevant articles were downloaded. Next, the context, methodology, and study findings were examined in order to determine the eligibility of the full-text publications. At the end of this stage, 139 records were eliminated because they were not relevant to the research questions.

Included

As a result of the screening process, 49 studies were included in the final stage. 17 of the records focused on the challenges in employability, 11 on the challenges associated with learning sustainability, 15 on metacognitive strategies, and 6 on the advantages of Education 4.0.

Findings

Challenges in Employability

Four major themes have been generated following the systematic literature review. The first theme relates to challenges in employability. There are several subthemes under this theme which are discussed in 17 articles. The challenges of employability are categorised based on the stakeholders involved, namely graduates, institutions, industries, and the government.

Graduates often face several employability challenges. One significant issue is the lack of employability skills. Albina and Sumagaysay (2020) found that IT and Computer Science graduates in the Philippines exhibited low levels of critical skills such as entrepreneurial, critical thinking, and problem-solving abilities. Aloui and Shams Eldin (2020) similarly reported that low employability skills among graduates were a factor in the high unemployment rates in Saudi Arabia. There is a notable deficiency in digital skills especially in the private sector (Bikse et al., 2022). Studies also indicate that graduates lack soft skills such as problem-solving, critical thinking, leadership, communication, and interpersonal effectiveness (Chan et al., 2021; Mohamed Khodeir & Nessim, 2020). A study in Botswana also highlighted a lack of fundamental employability skills such as numeracy, literacy, and communication among students (Pheko & Molefhe, 2017).

Besides lacking employability skills, there is a significant skill gap between what graduates possess and what the industries require. Pappas et al. (2018) identified a mismatch in ICT skills among women entrepreneurs in Greece, while Graham (2017) noted that students prioritise IT skills over soft skills which are more valued by employers.

Graduates also struggle with a lack of work experience. A study found that students in Australia did not effectively link their past work experiences to future employability, lacking

an understanding of necessary knowledge and skills (Gilbert et al., 2022). Gender barriers further complicate employability, with studies by Gilbert et al. (2022) and Pappas et al. (2018) showing that female graduates face challenges in male-dominated industries like project management and ICT. Disability barriers are another issue, with graduates facing prejudice and negative treatment that lower their self-esteem and employability (Moriña & Biagiotti, 2022).

Higher education institutions contribute to employability challenges through outdated curricula. Bhatt and Smita (2021) observed that curricula in some institutions are heavily theoretical and lack practical applications, partly due to minimal collaboration with industry experts. Chan et al. (2021) noted that traditional, exam-oriented teaching methods hinder the development of practical skills. Similarly, Manan et al. (2021) emphasised that teacher-centred curricula do not support the development of critical thinking and problem-solving skills among graduates. In a couple of studies, students reported minimal support from faculties in terms of skills development due to outdated curricula (Chigbu & Nekhwevha, 2022; Gilbert et al., 2022). Kenayathulla et al. (2019) noted low employability skills among hospitality students, attributing this to insufficient exposure to practical experiences.

Meanwhile, poor management within industries is another barrier to employability. In India, it has been reported that there are limited senior positions and overworked teachers with less competitive salaries, which have led to poor job application in the education sector (Bhatt & Smita, 2021). Lack of communication between institutions and industries also affects graduates' internship placements, particularly for those with disabilities (Moriña & Biagiotti, 2022). Another study found that people with disabilities face misunderstanding and stigma by their employers and are not provided the necessary support needed for continuous employment (Ritchie et al., 2022).

In addition, there is an issue of missing policies in government. Cheng et al., (2022) pointed out a gap between the UK government's objectives for graduate employability and employer expectations, with the government focusing on knowledge accreditation and vocational skills, while employers prioritise soft skills. In Pakistan, Manan et al. (2021) reported a missing policy to address slow economic growth, and Pheko and Molefhe (2017) noted a decreasing labour demand in Botswana.

Table 2

Characteristics of Included Studies for Challenges in Employability

Authors	Year	Setting	Type of Research	Method	Sample/Tools
Albina & Sumagay say	2020	Philippines	Research	Quantitative	177 graduates in IT and Computer Science
Aloui & Shams Eldin	2020	Saudi Arabia	Research	Quantitative	102 graduates at the Tathleeth Faculty of Arts and Science at the University of Bisha
Bhatt & Smita	2021		Review		
Bikse et al.	2022		Review		

Chan et al.	2021	China	Research	Quantitative	4,424 students from Hong Kong Polytechnic University
Cheng et al.	2022		Review		
Chigbu & Nekhwevha	2022	South Africa	Research	Quantitative	335 university students
Gilbert et al.	2022	Australia	Research	Mixed method	94 students in Project Management
Graham	2017		Review	Content analysis	
Islam	2022	Bangladesh	Research	Quantitative	361 undergraduate and graduate-level students
Kenayat hulla et al.	2019	Malaysia	Research	Quantitative	841 hospitality students
Manan et al.	2021	Pakistan	Research	Mixed method	426 students in a survey 25 students in interviews
Mohamed Khodeir & Nessim	2020	Egypt	Research	Mixed method	100 fresh graduates and senior students 15 professionals and academicians
Moriña & Biagiotti	2022		Review		
Pappas et al.	2018	Greece	Research	Mixed method	1035 women
Pheko & Molefhe	2017	Botswana	Research	Qualitative	83 students enrolled in two Psychology courses
Ritchie et al.	2022	United Kingdom	Research	Secondary qualitative analysis	38 informants

Barriers to Learning Sustainability

The second theme relates to the barriers to learning sustainability. 11 studies were reviewed and these studies discuss the challenges associated with this theme. The challenges are divided into several subthemes which are barriers related to mental health, time, communication and technology.

Mental health issues significantly impede learning sustainability for students. During the COVID-19 pandemic, studies highlighted how the absence of face-to-face interaction and the transition to online learning negatively impacted students' moods and motivation (Chaves, 2021; Gu et al., 2022). Laar et al. (2021) reported that quarantine measures and online classes led to increased mental pressure, with students experiencing anxiety and stress. Jaradat and Ajlouni (2021) found that many students struggled with mental health deterioration and required counselling services to cope with these challenges.

Apart from that, studies found time management difficulties are hindering students' ability to achieve learning sustainability. It has been noted that 57.3% of undergraduate students

faced challenges in managing their time during the pandemic due to poor time management skills, suggesting the need for training sessions (Jaradat & Ajlouni, 2021). Dwi et al., (2020) similarly found that students struggled to manage time and study independently, often missing online class schedules and assignment deadlines. Sarvestani et al. (2019) observed that graduate students who juggle work and study were facing overlapping schedules, complicating effective time management. Additionally, Battistella et al. (2020) highlighted that time constraints in corporate settings limited opportunities for reflective learning, which is essential for learning sustainability.

Additionally, another challenge in learning sustainability is related to communication. Almossa (2021) analysed Twitter data from Saudi Arabian universities, revealing students' frustrations with poor communication from professors, leaving them feeling directionless. Xia et al. (2022) found that unclear instructions and lack of support from instructors forced students to spend more time on tasks. Laar et al. (2021) emphasised the importance of face-to-face interaction, noting that online classes hinder effective peer communication and collaboration. Lee et al. (2019) identified work commitments and access problems as key factors contributing to poor participation in online classes in Malaysia.

Lastly, technological barriers hinder students from achieving learning sustainability. Studies reported that poor internet connections and low bandwidth are negatively affecting students' online learning experiences (Chaves, 2021; Dwi et al., 2020; Jaradat & Ajlouni, 2021; Sarvestani et al., 2019). Dwi et al. (2020) noted that students often faced financial burdens to renew their internet quotas. Sarvestani et al. (2019) highlighted the inadequacy of students' devices, which often had software and hardware issues that are unsuitable for virtual education. Mhandu et al. (2021) pointed out that students in rural areas had little to no access to computers. Xia et al. (2022) found that students with limited prior exposure to technology struggled with basic tasks like downloading and file sharing, indicating a lack of technological skills. The table below summarises the barriers to learning sustainability categorised by types.

Table 3

Characteristics of Included Studies for Barriers to Learning Sustainability

Authors	Year	Setting	Type of Research	Method	Sample/Tools
Almossa	2021	Saudi Arabia	Research	Mixed method	219,000 tweets
Battistella et al.	2020	Italy	Research	multiple-case study approach	3 case companies
Chaves	2021	Philippines	Research	Survey	53 junior management students
Dwi et al.	2020	Indonesia	Research	Survey	85 students in the English Language Education Department of Pekalongan University
Gu et.al	2022	China	Research	quantitative cross-sectional study	340 undergraduate students enrolled in the colleges

Jaradat & Ajlouni	2021	Jordan	Research	Survey	398 undergraduate students enrolled at the School of Educational Science at the University of Jordan
Laar et al.	2021	China	Research	Qualitative phenomenological study	56 university students enrolled in physical education programs
Lee et al.	2019		Review		
Mhandu et al.	2021	South Africa	Research	Ethnographic fieldwork	25 rural-based students 3 staff responsible for e-learning
Sarvestani et al.	2019	Iran	Research	Qualitative phenomenological study	10 students
Xia et al.	2022	China	Research	Mixed method	230 students

Application of Metacognitive Strategies

15 studies were found to be discussing the third theme related to the application of metacognitive strategies in education. The studies highlighted how metacognitive strategies are applied in three stages: Planning, monitoring, and evaluating.

Planning

Metacognitive strategies begin with a planning stage, essential for both teaching and learning processes. Ali and Yasmeen (2019) found that teachers create concept maps or outlines and determine learning objectives and resources before teaching sessions. In writing activities, students plan their writing by focusing on ideas and messages, and then draft their essays (Cer, 2019). Explicit teaching of metacognitive strategies is also crucial in reading comprehension, where readers choose strategies that work best for them during the planning stage (Çakici, 2017; Khellab et al., 2022). Cervin-Ellqvist et al. (2021) noted that engineering students review past exams to set learning goals, and Ghasemi et al. (2019) showed that setting specific goals for vocabulary acquisition is effective. In problem-based learning, students develop action plans to activate prior knowledge and understand problems, as seen in geography and pharmacy studies (Heuzeroth & Budke, 2021; Lobczowski et al., 2021; Rivas et al., 2022).

Monitoring

Monitoring involves ongoing evaluation of the learning strategy, with teachers providing feedback and reminders about timelines (Ali & Yasmeen, 2019). In writing, students identify necessary changes and language errors after the first draft (Cer, 2019). In reading, monitoring is done through Problem-Solving Strategies (PROB) like adjusting reading speed and predicting vocabulary meanings, as well as Support Strategies (SUP) like using dictionaries and note-taking (Çakici, 2017).

Cervin-Ellqvist et al. (2021) found that practice problems help students assess their understanding of concepts. In problem-based learning, monitoring ensures all group members understand the problem and allocate tasks effectively (Rivas et al., 2022).

Evaluating

Evaluating involves reflection on the learning process. Teachers evaluate previous lessons to improve future ones (Ali & Yasmeen, 2019), and students assess and revise their writing (Cer, 2019). In reading, students evaluate the effectiveness of their strategies through inner monologues and peer discussions (Çakici, 2017; Khellab et al., 2022).

Cervin-Ellqvist et al. (2021) noted that reflection includes summarizing and self-checking practice problems. In problem-based learning, students present solutions, self-evaluate, and provide feedback to peers, analyse mistakes and discuss improvements using reports, checklists, and learning logs (Ghasemi et al., 2019; Rivas et al., 2022).

Apart from the three stages, there are several subthemes developed under this theme discussing how metacognitive strategies are applied in education. The themes include training strategies, gender comparison and portfolio for metacognitive development.

Training Strategies

Drigas et al. (2022) and Rivas et al. (2022) reviewed various strategies for developing metacognitive skills, highlighting several effective methods. The method of loci, an ancient mnemonic technique, helps learners link new information to prior knowledge, organise information, and create associations, while the chunking technique involves grouping separate pieces of information into meaningful units for easier recall (Drigas et al., 2022).

Mind mapping aids in organising information, and decision diagrams assist in structuring questions during different learning phases (Drigas et al., 2022; Rivas et al., 2022). Self-testing or self-evaluation involves reflecting on learning and performance through instructor-guided rubrics, helping learners monitor their knowledge, performance, and final learning products (Drigas et al., 2022; Rivas et al., 2022). Including emotional content in learning materials can enhance memory retention, as the brain regions responsible for memory also process emotions (Kajka & Kulik, 2021; Rivas et al., 2022). Kajka and Kulik (2021) found that metacognitive strategies training, including emotional expression through mind-mapping, positively impacted response inhibition in children with ADHD, improving their impulse control. Additionally, multisensory learning and teaching others—techniques that involve retrieving and reorganising knowledge—are beneficial for memory retention and overall learning (Rivas et al., 2022).

Gender Comparison

Calafato (2020) conducted a study on students' self-regulation and learning motivation in Scandinavia. The research specifically examined the application of metacognitive strategies among students and found notable gender differences. The findings indicate that female students are more likely to employ metacognitive strategies compared to their male counterparts. This suggests that female students tend to engage more actively in planning, monitoring, and evaluating their learning processes. In contrast, male students were less inclined to use these strategies, which could impact their overall learning outcomes and motivation. The study highlights the importance of understanding gender differences in educational strategies to develop tailored approaches that can enhance learning for both genders.

Portfolio for Metacognitive Development

Mack et al. (2019) reviewed the widespread use of portfolios in medical schools and postgraduate medicine. These portfolios serve as archives of learning-related information collected by students over time. With reflective portfolios, students are able to develop reflective and metacognitive skills by outlining learning goals, recording experiences, and self-evaluating performance. Each portfolio is unique and personalised, available in paper or digital formats (e-portfolios). E-portfolios offer various template-based options, which some institutions prefer due to their advantages (Mack et al., 2019).

Table 4

Characteristics of Included Studies for Application of Metacognitive Strategies

Authors	Year	Setting	Type of Research	Method	Sample/Tools
Ali & Yasmeen	2019	Pakistan	Research	Qualitative phenomenological study	10 medical teachers
Çakıcı	2017		Review		
Calafato	2020	Scandinavia	Research	Mixed method	96 students learning Arabic
Cer	2019	Turkey	Research	Mixed method experimental research	44 pupils at a private secondary school
Cervin-Ellqvist et al.	2021	Europe, EEA and Switzerland	Research	Mixed method	416 engineering students
Drigas et al.	2022		Review		
Ghasemi et al.	2019	Iran	Research	Mixed method	51 EFL learners studying English at an aeronautical college
Heuzeroth & Budke	2021	Germany	Research	quasi- experimental	49 students in Geography class
Kajka & Kulik	2021	Poland	Research	Experimental	45 school children with ADHD
Khellab et al.	2022	Libya	Research	Experimental	60 students from the Faculty of Engineering Technology
Lobczowski et al.	2021	USA	Research	Qualitative case study	29 pharmacy students at a university in the south-east
Luzzatto et al.	2018		Review		
Mack et al.	2019		Review		
Rajasagaran & Ismail	2022		Review		
Rivas et al.	2022	Spain	Research	quasi- experimental	89 students in a first-year psychology course

Benefits of Education 4.0

The fourth theme relates to the benefits of Education 4.0. 6 articles have been reviewed which were focusing on this theme. The advantages of Education 4.0 are categorised according to stakeholders namely learners, educators, institutions and industries.

Education 4.0 tools and practices bring substantial benefits to learners and one of the advantages includes the improvement of communication. Choi et al. (2020) explored the use of visual thinking strategies (VTS) during online sessions, where students engaged in discussions prompted by visual aids, fostering peer interaction through verbal exchanges and real-time chat. Instructors facilitated these sessions, providing feedback and encouraging reflective dialogue. Students valued the collaborative nature of these sessions, resembling on-campus learning experiences. Furthermore, the integration of technology improves communication not only among peers but also between instructors, students, parents, and colleagues (Panagiotopolos & Karanikola, 2020). Furthermore, Education 4.0 encourages instructors to adapt teaching methods for online environments, promoting active learning and student-centred approaches that empower learners to discuss, collaborate, and create (Choi et al., 2020; Kunnari et al., 2021). This shift enhances students' autonomy through self-directed study, fostering practical skills applicable to real-world scenarios (Kunnari et al., 2021). Moreover, Education 4.0 facilitates the development of employability skills, with students acquiring technological proficiency and critical analytical abilities through digital tools and challenge-based learning (Porubčinová et al., 2020; Vilalta-Perdomo et al., 2022). Additionally, Education 4.0 promotes engagement and motivation by offering stimulating learning activities and materials, thereby enhancing learning outcomes and satisfaction (Choi et al., 2020; Panagiotopolos & Karanikola, 2020). Finally, Education 4.0 provides freedom and flexibility in learning, enabling access to educational resources anytime, anywhere and adapting tools to meet diverse students' needs (Kunnari et al., 2021; Panagiotopolos & Karanikola, 2020). Active learning environments under Education 4.0 reduce the pressure to provide correct answers, encouraging creativity and innovation among students (Choi et al., 2020; Vilalta-Perdomo et al., 2022).

For educators, Education 4.0 transforms teaching practices by incorporating digital pedagogy and learner-centred approaches. Instructors have moved away from traditional theoretical methods to adopt project-based, blended, experiential, and flipped learning models (Kunnari et al., 2021). These new approaches, supported by digital tools, improve the organisation and delivery of teaching, making lessons more engaging and effective (Porubčinová et al., 2020). Furthermore, Education 4.0 enhances assessment methods, introducing peer and self-assessment and e-portfolios, which provide a more comprehensive evaluation of students' skills and learning experiences (Kunnari et al., 2021). This shift not only improves teaching quality but also fosters a more interactive and reflective learning environment.

Institutions benefit from Education 4.0 through enhanced teaching methods, co-creation, collaboration, and cost-saving practices. The pandemic prompted instructors to migrate from traditional teaching to adapt and collaborate in developing new teaching materials and skills, which were shared through training sessions, workshops, and webinars (Kunnari et al., 2021). This collaborative approach enhances the overall quality of education and fosters innovation. Additionally, online learning practices are more cost-effective, reducing the need for physical learning materials and on-campus classes, particularly during times of crisis (Choi et al., 2020; Panagiotopolos & Karanikola, 2020). By integrating digital pedagogy, institutions can streamline their operations and allocate resources more efficiently, ultimately benefiting both educators and students.

Industries also gain significantly from Education 4.0 through increased collaboration with academic institutions. The integration of technology facilitates partnerships between industries and educational institutions, bridging knowledge gaps and maintaining business activities, especially during the pandemic (Kunnari et al., 2021). These collaborations include training programs, internships, academic competitions, and scholarships, which prepare students with the skills needed for the workforce. Moreover, industries benefit from expert advice provided by academic institutions, addressing specific challenges and driving innovation (Porubčinová et al., 2020). This symbiotic relationship ensures that industries remain competitive and that students are well-equipped with relevant skills for their future careers.

Table 5

Characteristics of Included Studies for Benefits of Education 4.0

Authors	Year	Setting	Type of Research	Method	Sample/Tools
Adewale & Tahir	2022	Nigeria	Research	Survey	270 students in higher education institutions
Choi et al.	2020	Korea	Research	Mixed method	60 second-year undergraduate nursing students
Kunnari et al.	2021	Vietnam	Research	Qualitative case study	6 partner institutions 35 teachers
Panagiotopoulos & Karanikola	2020	Greece	Research	Survey	233 primary education teachers
Porubčinová et al.	2020	Slovakia	Research	Literature review and qualitative interview	15 education professionals at the Faculty of Civil Engineering of STU
Vilalta-Perdomo et al.	2022	United Kingdom	Research	Qualitative document analysis	302 undergraduate business students

Discussion

This review has identified challenges in employability namely skills gap (Graham, 2017; Pappas et al., 2018) and minimal support by the institutions (Chigbu & Nekhwevha, 2022; Gilbert et al., 2022). These findings align with several key themes identified in previous research (Ang, 2015) highlighting the existence of skill discrepancies and the importance of institutional support. This indicates that more studies are needed to address the issues behind the gap between graduates' skills and employers' expectations. Studies by Graham (2017) and Pheko and Molefhe (2017) indicate that employers increasingly prioritise soft skills such as communication, critical thinking, and interpersonal effectiveness over technical skills. This shift in focus suggests that educational institutions need to place greater emphasis on developing these skills to meet evolving industry demands. This review highlighted another challenge in employability which is caused by outdated curricula (Bhatt & Smita, 2021; Chan et al., 2021). This issue urges institutions to regularly improve curricula to build skills among students to match the needs of the industries, as highlighted by Ma'dan et al. (2020).

This review found the challenges associated with learning sustainability like mental health barriers (Chaves, 2021) and time management issues (Jaradat & Ajlouni, 2021). Woolis' (2021) Sustainable Learning Framework theoretical framework provides practical examples of how barriers can be addressed in real-world settings. The framework's discipline of Democratic Engagement emphasises the need for resources, safety, and support to ensure active learning. This aligns with the need for mental health support and counselling services to help students cope with anxiety and stress (Jaradat & Ajlouni, 2021). The framework includes Purposeful Pedagogy, which advocates for authentic assessments and evidence-informed methods to design learning. By incorporating structured time management training and flexible learning schedules, institutions can help students manage their time more effectively (Woolis, 2021). The framework highlights Systems Thinking which encourages the identification and combination of relationships, patterns, and interdependencies in teaching and learning. By fostering strong communication networks and communities of practice, educators can enhance the clarity of instructions and provide better support, mitigating the challenge of learning sustainability which is poor communication (Almosa, 2021).

This review has identified the role of portfolios in developing metacognitive skills among learners (Mack et al., 2019). This aligns with another study by Mohamad et al., (2016) that highlights the benefits of documenting learning goals, experiences, and self-evaluations over time. They support the use of portfolios, particularly e-portfolios, as a tool for enhancing reflective and metacognitive skills, providing a new dimension to the application of metacognitive strategies in education.

Philip (2018) highlighted high levels of self-regulation in metacognition among undergraduates, with a preference for cognitive strategies like rehearsal. Similarly, the current finding emphasises the importance of monitoring and evaluating as part of metacognitive strategy application (Drigas et al., 2022; Rivas et al., 2022). Both studies underscore the need for continuous feedback and reflection to enhance learning, with the current finding providing a more detailed framework for implementing these strategies in various learning contexts, such as writing, reading comprehension, and problem-based learning (Ali & Yasmeen, 2019; Cer, 2019; Heuzeroth & Budke, 2021). These insights suggest that a comprehensive and integrated approach to metacognitive strategy training can significantly enhance learning outcomes and equip students with essential skills for academic success and beyond (Kajka & Kulik, 2021).

The current finding highlights the importance of understanding gender differences in metacognitive strategies application (Calafato, 2020). More studies could be done to help educators develop tailored approaches that can enhance learning for both genders. By recognising these differences, educators can create more effective teaching methods and support systems that cater to the unique needs of male and female students, ultimately improving their academic performance and self-regulation skills.

The current findings on the benefits of Education 4.0 align with previous research by Fisk (2017) and the Malaysian Ministry of Higher Education (2018) in several key areas, such as accessibility, tailored instruction, and enhanced collaboration. The benefits for educators noted in the current finding align with Fisk's (2017) emphasis on tailored instruction and project-based learning. The shift from traditional theoretical teaching methods to digital

pedagogy and learner-centred practices, such as project-based learning and flipped learning, has enhanced the teaching and learning process (Kunnari et al., 2021). Fisk also mentioned that educators would take on a new role as facilitators, which is evident in the current findings on improved teaching practices and co-creation among educators (Kunnari et al., 2021). The adoption of more blended and online learning practices reduces the need for physical learning materials and on-campus classes, making education more affordable and feasible (Choi et al., 2020; Panagiotopoulos & Karanikola, 2020). This reflects the Malaysian Ministry of Higher Education Blueprint's focus on transforming learning and teaching through 21st-century pedagogies (Ministry of Education, 2015). Furthermore, industries benefit from increased collaboration with educational institutions due to Education 4.0, aligning with Fisk's (2017) emphasis on hands-on experiences through internships, mentorships, and team projects. The current study shows that this collaboration includes training programs, internships, academic competitions, and scholarships, helping bridge the knowledge gap between academia and industry (Kunnari et al., 2021). This ensures that students develop employability skills, such as technological proficiency, problem-solving abilities, and critical thinking, which are essential for the modern workforce (Vilalta-Perdomo et al., 2022).

By integrating the theoretical insights from previous studies with the practical applications identified in this review, learners, educators and institutions can develop comprehensive strategies to leverage the full potential of metacognitive strategies and Education 4.0, ensuring that all stakeholders benefit from these innovative practices, particularly in solving the challenges of graduate employability and learning sustainability.

Conclusion and Implications for Future Research

The integration of metacognitive strategies and Education 4.0 offers promising solutions to the challenges of employability and learning sustainability. This study highlights how these approaches can enhance learner engagement, improve teaching practices, foster institutional collaboration, and strengthen industry ties, ultimately leading to enhanced employability and sustainable education. Metacognitive strategies help students become more aware of their learning processes, strengths, and areas for improvement. This self-awareness, combined with Education 4.0 tools, prepares students for the dynamic demands of the job market. Project-based learning, internships, and industry collaboration provide practical experiences that enhance employability. Additionally, metacognitive strategies promote lifelong learning by encouraging students to take ownership of their learning journey. Education 4.0 tools support continuous and flexible learning, enabling students to adapt to changing circumstances and technologies.

The findings of this study have several implications for future research, particularly in exploring the synergy between metacognitive strategies and Education 4.0, addressing existing gaps, and innovating further. Future research should focus on long-term studies to assess the sustained impact of metacognitive strategies and Education 4.0 on employability. Tracking graduates' career progress and skill development over time will provide valuable insights. Given the barriers related to mental health, future studies should explore how metacognitive strategies and Education 4.0 can address stress, anxiety, and other mental health issues among students.

Future research should also investigate how these educational approaches can address issues of equity and accessibility, ensuring that students from diverse backgrounds and regions benefit equally from technological advancements. Studies should examine the effectiveness of professional development programs designed to help educators integrate metacognitive strategies and Education 4.0 tools into their teaching practices. Further investigation is needed into how emerging technologies, such as artificial intelligence, virtual reality, and augmented reality, can be integrated with metacognitive strategies to enhance learning experiences.

In conclusion, this review has discussed the challenges that come with employability and learning sustainability and how metacognitive strategies and Education 4.0 could significantly enhance educational outcomes by fostering learner engagement and skills development, benefit educators by improving teaching practices, enabling improved and tailored instruction, and address the skill gap issue by strengthening industry-academia ties, thus preparing students for their future career.

Acknowledgement

This work was supported by Malaysian Ministry of Higher Education Fundamental Research Grant Scheme [Grant No: FRGS/1/2018/SSI09/UIAM/02/3].

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