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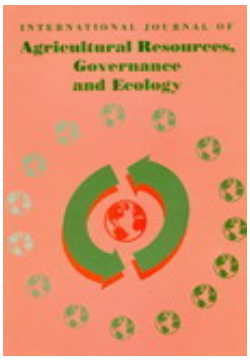

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Integrating circular economy approach into education: talent management, agricultural innovation, and bioeconomy transformation

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Integrating circular economy approach into education: talent management, agricultural innovation, and bioeconomy transformation

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Abstract: This paper examines the integration of the circular economy approach into education systems, focusing on the development of creative, critical thinking, and ethical practices among students. Circular economy, in the context of talent management and bioeconomy, offers a transformative model for addressing global challenges such as climate change and resource inefficiency. The study explores how a national educational framework, particularly in developing countries, can align talent development with circular bioeconomy needs. By analysing the intersection of education, agriculture, and circularity, the research provides insights into how curriculum redesign and strategic educational investments can foster innovation and resilience. This study has the potential to inform policy decisions and educational reforms that can contribute to sustainable national growth and the global circular economy.

Keywords: circular economy; bioeconomy; talent development; higher education institutions; HEIs; reskilling; upskilling; circular bioeconomy; national needs-to-skill alignment; education systems; sustainability; innovative education models.

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1 Introduction

Resource deficit can be effectively mitigated through the efficient use of materials and the redirection of waste into production cycles, thus contributing to a closed-loop system of material flows (Morales et al., 2022). This model, commonly referred to as circularity or resource efficiency (Pena et al., 2020), has been widely examined in industrial contexts

such as rubber (Ghazali and Zbiec, 2022) and oil palm biomass (Ghazali, 2023). However, the circular economy paradigm can also be extended metaphorically and analytically to the domain of human capital, where efficiency translates into enhanced talent quality and functionality. In this framework, dysfunctional human resource practices can be seen as 'waste' that needs to be identified, rerouted, or upgraded to sustain productivity and institutional vitality (Ghazali and Fadzlee, 2024).

Talent development failures often result from neglecting key factors essential to talent management. Organisations suffering from mismanaged human capital typically underperform (Chamorro-Premuzic, 2014), particularly when talents remain untapped or undervalued. This leads to disengagement, inefficiency, and a reliance on unqualified personnel who may resort to outsourcing, contract cheating, or falsification of competence. In such settings, superficial success is often sustained by informal networks that perpetuate mediocrity and inhibit systemic reform.

Education systems are foundational to a nation's intellectual capital, socio-economic advancement, and long-term innovation, provided they are staffed and managed by a critical mass of high-quality professionals. Technocrat Dato' Sri Idris Jala has emphasised that the production of quality teachers must be prioritised to realise the vision for national development articulated by Datuk Yacoob Wan Ibrahim (Mansor et al., 2012).

Yet, recent studies suggest that the Malaysian education sector struggles to attract and retain individuals of appropriate calibre (Mansor et al., 2012; RGD, 2018), contributing to institutional instability and rising student dropout rates (Carlo et al., 2024; Anis, 2024; Lim, 2023; NCES, 2020). Learning has become increasingly dependent on private tutoring, and systemic inequalities have been exacerbated by the widening gap between rising living costs and stagnant average incomes. These conditions elevate the cost of education and deny opportunities to the economically disadvantaged. Without targeted interventions to address these longstanding systemic weaknesses, Malaysia risks a broader socioeconomic decline, in line with Andreas Schleicher's assertion that "your school today is your economy tomorrow" (Awani, 2024).

Moreover, universities that have traditionally prioritised research must reconsider and expand their role. Teaching and research should be mutually reinforcing: while teaching draws strength from research insights, research outcomes must, in turn, inform and enrich education, equipping graduates with the skills and distinctiveness needed for global employability and innovation. This has important implications for sectors such as agriculture, where addressing complex global challenges, like climate change, environmental degradation, and resource scarcity, requires the integration of farming and environmental knowledge into educational curricula. Such efforts demand a shift from conventional top-down knowledge dissemination toward more participatory, bottom-up approaches that are responsive to local contexts and acknowledge agriculture's wider contributions to wellbeing, health, equity, and sustainable development (Spataru et al., 2022).

This research aims to explore an underexamined nexus between circular economy principles and education systems, introducing an innovative perspective that positions talent development as a cornerstone of sustainable bioeconomy transitions. The study contributes to the discourse by analysing how educational institutions, especially in the context of developing countries, can be strategically reoriented to drive circularity, ethical entrepreneurship, and systemic resilience in agriculture and related sectors. It advances the conceptualisation of education not merely as a transmitter of knowledge,

but as an active agent in cultivating a future-ready workforce capable of responding to complex environmental and economic challenges through circular thinking.

The key research questions guiding this inquiry are:

- In what ways can educational systems be redesigned to embed circular economy values that enhance creativity, critical thinking, and ethical integrity in learners?
- How can talent management frameworks, particularly in resource-constrained and agriculturally dependent nations, bridge the gap between educational outcomes and the workforce needs of a circular bioeconomy?
- What transformative potential lies in cross-sectoral collaboration between education and industry for accelerating the adoption of circular practices in national development strategies?

The paper is organised as follows: after the introduction, the methodological framework is presented. This is followed by a section on the results and analysis, which first examines the educational landscape in Malaysia, highlighting key challenges and issues within the system. Next, the paper explores good practices from the Asia-Pacific region and the EU, particularly those in which Malaysian partners have been involved or informed. Following this, the concept of graduate tracking by a national talent management hub is introduced, emphasising skill reassessment for graduates from both academic and TVET streams to ensure the functional integrity of the civil service. The paper then presents the model of a spiralling talent management loop, which generates individuals to manage education and other sectors, leading to an umbrella effect where high-quality talent nurtures other institutions. The result part concludes with an exploration of the needs-to-skill alignment in the context of a circular bioeconomy, addressing some structural challenges in the agricultural sector.

2 Methodology

This study adopts a conceptual and exploratory approach to develop a novel analytical analogy between industrial circularity and talent management. While grounded in general theoretical reasoning, the research specifically focuses on Malaysia as a case study, using it as an empirical context to observe how inefficiencies in the education sector affect national development. Malaysia is selected due to its complex education-to-industry dynamics, systemic challenges in human capital management, and growing relevance in regional development debates. At the same time, examples from selected international practices are included to highlight best practices and comparative insights that inform the Malaysian context.

The study employs mixed qualitative and quantitative empirical research with conceptual and analytical systems of data treatment. It draws upon a synthesis of expert insights gathered through the Malaysian co-authors' long-standing professional engagement with individuals holding leadership roles and relevant thematic experience. Rather than relying on a formal questionnaire, the analysis reflects accumulated knowledge and observations derived from ongoing interactions, dialogues, and collaborative activities with these experts over time. This approach allowed the research team to capture nuanced, experience-based perspectives across a broad age spectrum (17 to 95 years) and from individuals actively involved in domains central to the study.

Experts were approached through informal and formal channels, drawing on participation in thematic workshops, public consultations, and professional exchanges. For example, Asia-Pacific Economic Cooperation, APEC, 2024 Workshop, Promoting Circular Economy in the Construction Industry within the APEC Region Using Industrial Symbiosis Approach, wrapping up the critical assessment of circular industrial practices was analysed to chart the advanced achievements, challenges and solutions implying the nations' acumen in troubleshooting circularity issues to actualise the ideas for sustainability.

Programmes organised by nations lauding the principle of circularity and commercial practices in tertiary curriculum and industrial practices were reviewed. Besides education topics on circularity, elements like teaching methods to instil circularity were captured. The rich contents from ERASMUS' boosting bioeconomy initiatives within the higher education institutions (HEIs) curricular project set up by about 20 countries in Europe and several Asian partners were also analysed. FOEBE and CL4bio (CL4bio Erasmus+ 2024) contents were analysed to capture the transformative elements for incorporation in and recommendation from the current study.

The primary sources of data were supplemented with quantitative statistical data from specialised literature.

3 Results and analysis

3.1 Educational landscape in Malaysia and good practices from the Asia-Pacific Region

Figure 1 illustrates the empirical manifestations of academic misconduct in various forms. The height of the (┼) markers represents the severity of each incident, referred to as 'shock intensity', which increases along the vertical axis. Lower markers indicate phases of 'relaxation', wherein the recurring nature of such events led the investigators to view them as expected occurrences. However, as these incidents persisted and began to pose challenges in academic evaluations, they were subsequently addressed through scholarly discourse, such as journal publications and workshops, aimed at developing strategies to mitigate academic misconduct. In all reported cases, experts with experience supervising Malaysian students, both within Malaysia and abroad in countries enforcing strict plagiarism regulations (e.g., Australia), confirmed the described encounters. Table 1 provides a detailed account of the cases documented over 30 years.

Cases involving the leak of national examination questions [LE] by teachers and guardians were included, considering the massive adverse impact on students' resilience and ability to initiate ideas independently at the varsity. The incident is also undesirable and rules out the authentic measure of a student's intellectual ability.

However, recent developments also highlight a noteworthy Malaysian initiative aimed at advancing circularity and entrepreneurship training. Despite ongoing domestic challenges related to labour shortages and logistical constraints, a Malaysian contractor has taken a bold step by establishing an artificial intelligence (AI) start-up in the UK. This AI-based construction company is among the first to apply AI technologies to the sector, using them for planning, safety monitoring, and process simulation. By analysing various material dimensions, the company enhances predictive capabilities and helps prevent construction failures (Tiong, 2024). Although not based in Malaysia, the firm

actively provides internship opportunities to Malaysian students, reflecting a strong commitment to talent development and knowledge transfer. Such efforts contribute significantly to equipping Malaysian youth with the competencies needed to meet global standards for transformative nation-building – an ambition that remains underrepresented outside select professional programmes.

Figure 1 Data mining timeline marking the shocks ensuing the encountered academic misconduct described in Table 1 (see online version for colours)

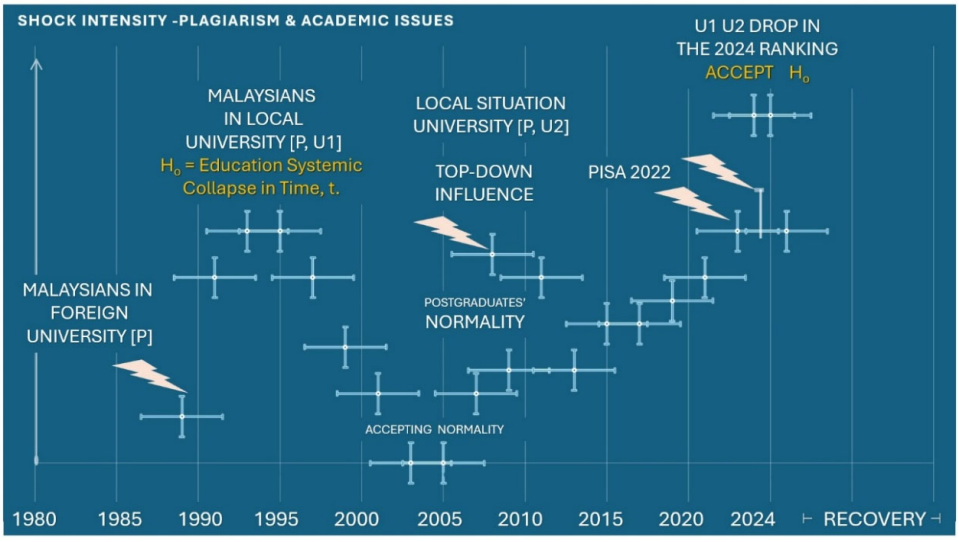


Table 1 Challenges in talent development defining the problem statement of the study

#	*Year*	*Cases/incidences*
1	1988	'Quota system' imposed upon Malaysian students. Narratives from funding body.
2	1988	International matriculation students rerouted to Canadian universities,
3	1991	Collusion plagiarism (CP) amongst Malaysian senior students in Australia, flashing back to a decade's experience.
	1992–1993	Confession on leak of national exam (LE) question amongst the elite secondary school leavers in Malaysia who flashed back the 1988 final-year experience.
4	1994–1997	Plagiarism amongst Malaysian students in a Malaysian university raise quality question. A hypothesis on paralysis of the system was projected.
5	2004–2006	Plagiarism amongst Malaysian students in a local university.
6	2006–2010	Verbatim plagiarism [VP] detected in students' written assignments.
7	2011–2015	Leak of the national primary school exam [LE] question (P1)
8	2016–2020	Plagiarist allowed to pass project-based course by silencing and backfiring the supervisor as assessor.
	2021–2023	Root causes of academic misconducts and their repercussions – a hypothetical test result surfacing in PISA2022.
9	2024	Times Higher Education (THE) ranking correlated results. IELTS heightened requirement for VISA.

Some interesting good practices in this area can be found in the Asia-Pacific Region. For example Hempblock, Block Texx, and Sustainability Victoria (Shooshtarian, 2024) have emerged as key industrial symbiont partners in Australia's construction sector, a sector identified as one of the country's highest emitters. These partners have not only pinpointed major challenges but also outlined strategic responses to overcome accounting and operational inefficiencies through the adoption of circular economy principles. As a result, the Australian construction industry is now aligning its practices with circular strategies while ensuring compliance with four ISO standards developed by the European Union (Shooshtarian, 2024).

In Southeast Asia, Singapore sets a leading example in resource management efficiency, recording the lowest waste generation among Asia-Pacific Economic Cooperation (APEC) countries (Al-Qudsy, 2024). One notable initiative, Zero Waste SG (2023), promotes a zero-waste, resource-efficient framework that has helped position Singapore as a model of 'trash-for-cash' profitability. Over the past five years, the country has effectively maintained a near waste-free status by converting incinerated solid waste (Liu, 2024) into construction bricks and repurposing gases for electricity generation. This closed-loop resource management system exemplifies a successful implementation of circular economy principles at the national level. Despite its small geographic size, Singapore's commitment to sustainability reflects its capacity to manage human capital strategically in support of circular economic goals.

Singapore's leadership in zero-waste initiatives is mirrored in the performance of its youth in international assessments. The country's outstanding results in PISA 2022 (OECD, 2023) are indicative of the broader societal commitment to innovation, efficiency, and education. Similarly, Singapore's consistent presence among the top institutions in the 2023 Times Higher Education rankings (THE, 2024), particularly through the National University of Singapore (NUS), highlights the connection between adult competence and youth achievement. Together, these accomplishments reflect a holistic national strategy that integrates sustainability, education, and human capital development to drive circular economy success.

The profit potential of circular economy models often remains obscured due to their emerging, technology-driven character and the complexity of the associated business models. Start-up capital requirements can be particularly high when waste management and conversion are central to the enterprise. Nevertheless, through innovation and interdisciplinary collaboration, scientists and industry practitioners continue to close material loops, reducing waste accumulation and enhancing sustainability. Compliance with stringent environmental regulations is increasingly facilitated by robust environmental accounting systems, which offer tangible evidence of carbon footprint reduction.

Industrial symbiosis presents a viable pathway for redistributing the costs of waste conversion, transforming them into shared economic value through open and collaborative business models. Globally, prominent companies have demonstrated success in zero-waste management through inventive problem-solving strategies. In the pulp and paper industry, for example, Andritz Inc. has made significant strides by implementing zero-waste syngas production from forest residues. Meanwhile, the circular biofuel sector increasingly intersects with AI technologies, including in areas such as fossil fuel detection and drilling, to optimise fuel blends (Halis et al., 2024).

3.2 EU championing the circular bioeconomy

Not only do the industrial sustainable practices related to circularity reflect intellectual performance, but also the profound functionality of national talents. The circular economy is emerging in countries like Denmark, Spain, Poland, Austria, and Australia, with European Countries in the lead. As a development strategy, the circular economy seeks to transform and optimise the use of materials and energy, driving significant changes in education (Heshmati, 2018). Various EU-funded projects, including educational ones, deal with broader aspects of bioeconomy, facilitating the passing of knowledge in these areas as well as preparing and turning ideas into manageable and feasible blueprints. Erasmus+ initiatives demonstrate a strategic educational approach by fostering learners' ability to view rejection not as failure, but as a constructive element of personal and professional growth. This mindset supports the integration of corrective feedback within the learning ecosystem, where educators adopt diverse roles – as coaches, mentors, peers, and counsellors – to guide and support students throughout their development, contributing to the progressive enhancement of talent and the development of a skilled, future-oriented workforce. EU experts have been working to integrate circular bioeconomy principles into curricula, moving beyond purely scientific perspectives to emphasise the systemic sustainability that can be achieved through the involvement of skilled professionals (Drejerska, 2024; Cavallasca, 2024; Nobre et al., 2023).

Within this context, several Erasmus+ funded projects stand out. Starting from the one focused on the development of innovative teaching methodologies, Creative Learning for Boosting Bio-Economy within HEIs' Curricula (CL4bio Erasmus+ 2024), aims to connect educators and students from diverse backgrounds by exploring the intersection of the bioeconomy and creative learning methodology (CLM). The project aspires to inspire the next generation of students by offering a distinctive learning experience that combines hands-on creative tools, cutting-edge research, and collaborative learning opportunities. At the time of writing, the project is in the phase of analysing the outcomes of its early implementation. The team is actively engaged in developing innovative teaching practices for lecturers, including the design of modular training components for trainers and the promotion of reflective teaching methodologies. The continuous exchange of best practices in creative learning and bioeconomy education among experts is central to the project's success. A notable example of these efforts is the in-person meeting on active learning and teaching held at the University of Aveiro, Portugal, where both undergraduate students and educators participated in a series of activities. Further insights, detailed event descriptions, and participant testimonies are available, for example, on the project's official YouTube profile (Project CL4BIO, 2025).

Then, the FOEBE and FOEBE+ projects are designed to equip students in the bioeconomy field with sustainable entrepreneurship skills, thereby supporting the broader goal of accelerating the bioeconomy's expansion across Europe. These projects focus on designing skills portfolios and curricula for entrepreneurship in the bioeconomy, as well as teaching practices, creation of a dedicated eLearning platform with add-on modules and conducting mixed-mode training. Courses conclude with an intensive study week, which has been organised so far in Bologna, Warsaw, and Wageningen, where students had complementary lectures, site visits and a final project leading to a start-up idea. Through the programme, students are scaffolded by mentors and practitioners. The polished versions of the project output serve as a prototype for students to translate into

their entrepreneurship or start-up attempts. History of success (start-ups, employment in start-ups and awards) can be traced on LinkedIn groups (FOEBE Plus Erasmus+, 2025), as cohort members are usually connected and reporting activities, reviewing courses and reporting achievements and success stories.

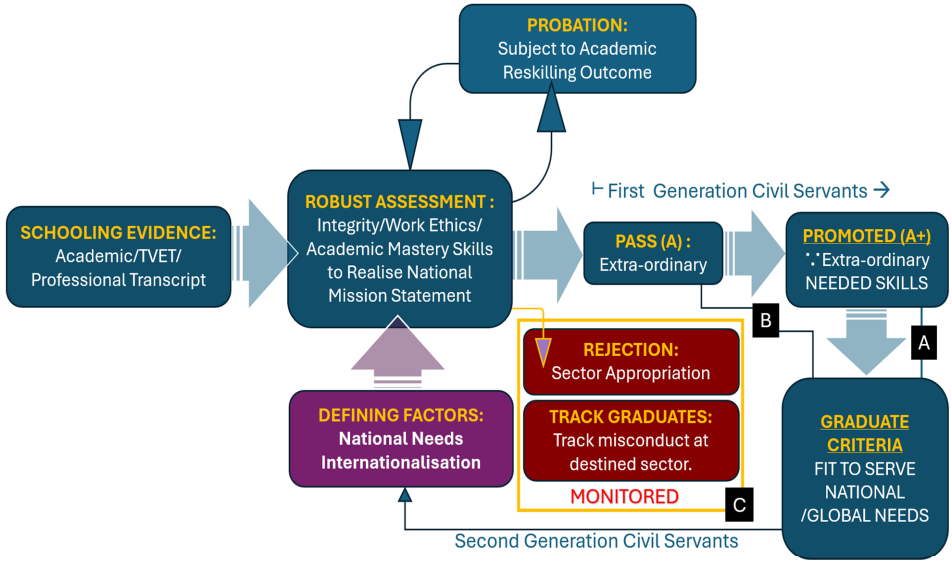
Renowned for advancing Technical and Vocational Education and Training (TVET) and promoting the circular bioeconomy through vocational pathways, Erasmus+ projects have also played a central role in strengthening workforce development across EU countries. A prominent example of such vocational initiatives is the establishment of Centres of Vocational Excellence (CoVEs). CoVEs are designed to foster innovation and excellence in vocational education by creating collaborative ecosystems involving a wide range of local stakeholders. These centres aim to deliver high-quality vocational training, promote entrepreneurial activity, support the diffusion of innovation, and serve as hubs of knowledge and innovation for businesses, especially small and medium-sized enterprises (SMEs). Notable examples include the Allview project and the CoVE initiative for the European wood and furniture industry, both supported by the European Commission under Erasmus+ Key Action 3. A huge consortium of 22 partners from the EU undertook very complex activities, aiming at new, emerging challenges for the sector: digitalisation, Industry 4.0, circular economy, and corporate social responsibility. Activities consist of mapping companies, HEI and VET schools and connected organisations and bringing them together with numerous activities, starting from independent add-on courses, student and teacher exchanges, innumerable publications and workshops, ending with connecting online platforms providing educational content for schools and companies, professional support and securing jobs within EU companies (Allview, 2024).

The aforementioned Erasmus+ project examples, either in full or in selected components, have been followed by Malaysian partners. Their participation reflects a growing international interest in integrating vocational and bioeconomy-focused education with innovative pedagogical approaches, where emphasis is placed not only on content development but also on pedagogical effectiveness. On-site programmes that facilitate student-entrepreneur engagement are particularly valued, alongside efforts to enrich teaching practices through a blend of online, in-person, and hybrid learning modalities tailored to diverse learner needs. A comparable initiative in Malaysia is exemplified by one of the country's first University-in-Industry models (Ghazali and Fadzlee, 2024), implemented by Peninsular College of Technology in partnership with the University of Plymouth, UK. This initiative involves prominent industry leaders such as Bosch Rexroth and LAM Research, who serve as 'millionaire mentors' to guide students in acquiring the advanced competencies required by the logistics sector and related industries, particularly in the context of Industry 4.0.

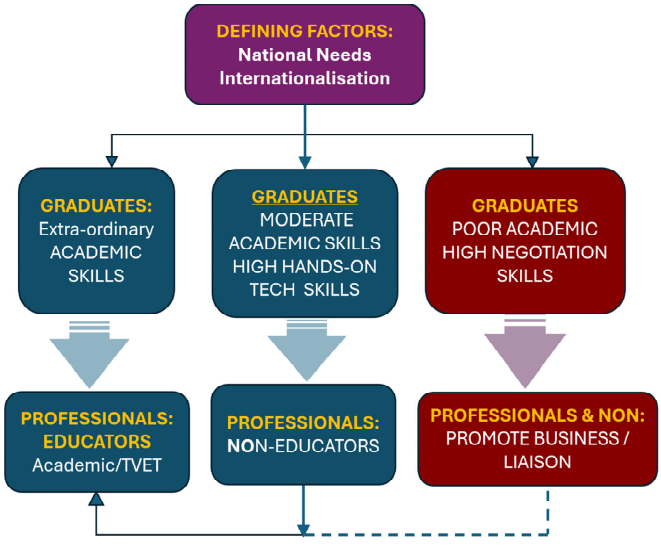
3.3 Rethinking the learning foundation

Fostering creativity is key to a circular economy. The global practices engendering success are mainly driven by nations enabling creative thinking, which is boosted by the mastery of the language or instructional medium. Beyond simple communication, experts discovered language proficiency as an enabler for growth, innovation, problem-solving skills and acceptance of cultures, perspectives and ways of thinking (Xia, 2022; ESLLP, 2024; Rahmat, 2020).

Figure 2 Graduate tracking by national talent management hub in charge of (a) skill reassessment of (b) graduates from the main academic and TVET streams to ensure the functional integrity of civil service (see online version for colours)



(a)



(b)

Bilingualism is an added factor for creativity due to the switching back and forth between languages that promote cognitive processes associated with creativity (Xia, 2022). From that light, the stringent requirement for IELTS (International English Language Testing System) imposed upon learners does play a role in quality assurance. Saudi Arabia sets, for example, English as one of the principal subjects in its university pre-professional programme (UPPP) as the foreign language is the Educational Medium

of Instruction (EMI). Aldarmahi et al. (2024) captured the effectiveness of the programme, and students' scoring in the UPPP serves as the predictor for their performance in the university's professional health science programme. Indeed, a globally certified professional programme sets language proficiency as a prerequisite, and it becomes apparent that the stepping stone to learn and enforce circularity is the mastery of the learning language, which must be the groundwork for the struggling nations.

Malaysia's JPA (Malaysian Public Services Department) move to upskill students to thrive in Australia's system is a hallmark of academic revival after phases of student rejections. Monitoring the execution of Australian pre-university programmes in Malaysia and proper coordination of the programme in 1988 was the effective corrective strategy, allowing thousands to be accepted to study and graduate from Australian universities in the subsequent years. With the right calibre coordination of the programme, Malaysian youths thrived and leapt by 3-grades for English. Among Asians, Singaporean parents, Indonesian and Thai HEIs were among the clientele of Australian universities due to the quality, curricular-focused education, affordability, and 100% graduate employability.

Reskilling thinking is the core of academic glory revivalism, driven by activities promoting creative, critical thinking for the nation to be manned by thinkers in no time. When Singapore initiated the Thinking School, Learning Nation (NLB, 2024) campaign in the 1980s, Prime Minister Goh Chok Tong projected the need to empower its people via quality education. Put such a reskilling strategy in Malaysia through redesigned talent hubs that nurture thinking, and desirable output may be expected to surface in 10–20 years. On top of the conventional strategy, a faster outcome is achievable through disruption in local recruitment and promotion processes (Figure 2).

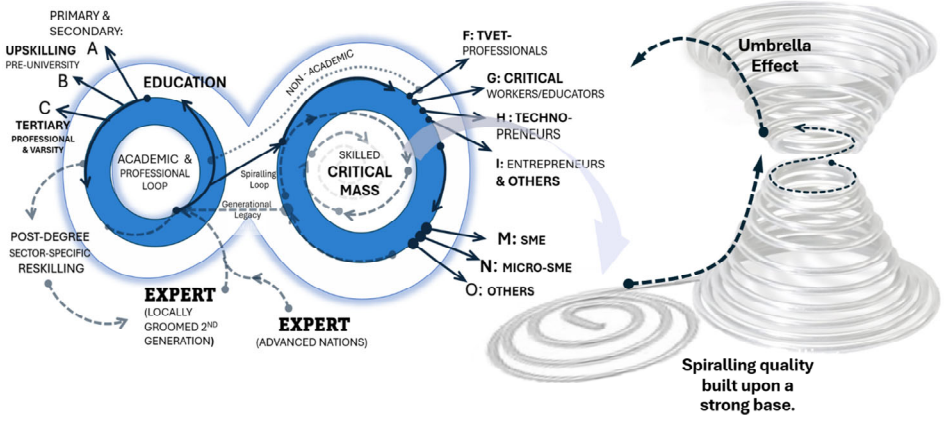
Employing a 'robustness assessment' process [Figure 2(a)] for the would-be teachers and lecturers is necessary to screen for educators with academic skills. Literature defines core academic skills as efficient reading ability (with a 100% comprehension score) and writing (or expressing) using ideas constructed as synthesised substances. These traits are mandatory enablers for assimilating the trending and obsolete global practices. Providing up-to-date materials to learners should be set as the primary goal to increase graduates' value. Trending global relevance, for instance, is the use of competitive problem-solving tools like analytics in business and accounting, in line with digital transformation. The strategy opens the door to graduates' entitlement to the potential global employability market.

Defining the national needs (e.g. skilled intellectual nation) is the cornerstone to cease dysfunctionality as this allows an accurate needs-to-skill alignment (NSA). For a talent development programme to be sustainable, it must provide the human power with the required skills. As we look from the side of corrective strategies, reskilling or upskilling may be costly, and a critical mass shift may be a more 'cost-effective' approach. By relocating to portfolios relevant to the group's strengths [Sector Appropriation, Figure 2(a)], an organisation will serve better by delegating the right skills to achieve realistic goals. The resource-efficient talent management offers mutual benefit without fake achievement, and the sector appropriation stage is to decontaminate the education sector.

The sustainable talent management model proposed in Figure 2(a) must be championed by recognising the various streams of intelligence [Figure 2(b)]. As renowned tertiary institutions are highly likely to produce academics with excellent academic skills, top-scoring cohorts signalled by the robust assessment deserve to be

promoted to allow them to lead the changes, without which, an umbrella effect (Figure 2) is far-fetched. When it comes to human talent, efficiency results in a soaring quality necessary to keep functional manpower in check and dismiss the propagation of dysfunctionality (Ghazali and Fadzlee, 2024).

Figure 3 The spiralling talent management loop generates people to (a) manage education and (b) other sectors, leading to an umbrella effect as the top (quality) embodiment bends downwards to scaffold other institutions (see online version for colours)



Notes: NB: TVET = Technical and Vocational Education and Training; SME = Small and Medium Enterprise.

As educators in HEIs demonstrate expertise by effectively implementing circularity, their institutions can become reference points for guiding others beyond their academic communities; moreover, researchers are encouraged to share their experiences in teaching circular economy – as well as in other fields – to enhance understanding and enrich the literature with perspectives from diverse regions and disciplines (Lima et al., 2024). The umbrella effect is emerging as the duplication resembles the umbrella roles conferred by several nations championing the circular economy and actualising it on many fronts.

Again, enough exposure must be given to understand the gap between the top-scoring and the low-scoring nations. Negligence of the lived reality would lead to another loop of resource wastage from the failure to execute the rectification process. Deploying a smart system for the rectification process is, in this sense, analogous to cleansing or detoxification (Wolor et al., 2022) job, which in turn, is not an option.

A circular economy in talent management, therefore, requires careful selection, robust assessment and boldness to eliminate fake achievements that falsely reflect skills and continuously demand tricky, uneconomic skill outsourcing. Earlier analysis (Ghazali and Fadzlee, 2024) shows an inverse correlation between misconduct and the global ranking, re-emphasising the importance of acting against misconduct as a way of keeping the high ethical standards of an educational institution. The unconducive or toxic work culture is incompatible with others who desire an ethical work culture, and losing the skilled knowledge workers through brain drain is a concerning issue, signalling a collapse of the sector as predicted two decades ago (Figure 1).

3.4 Needs-to-skill alignment and circular bioeconomy perspective

A coherent talent management framework must align educators' key performance indicators (KPIs) with national priorities. A forward-looking KPI model should embed integrity and encourage educators to embrace multifaceted roles as coaches, supervisors, and mentors – roles that nurture students' critical thinking and cognitive growth. In this context, the outcomes of Scholarship of Teaching and Learning (SoTL) research offer a valuable measure of educators' service leadership and their commitment to nation-building. Thus, SoTL can serve as a relevant and NSA-aware benchmark for professional recognition. Aligning institutional reward systems with broader transformation goals is a vital step toward sustained national empowerment.

In the Malaysian context, where significant investment has long been made in youth development through overseas study programmes, the reintegration of graduates into the national workforce should be prioritised and operationalised as a KPI. Furthermore, institutions that take a firm stance against academic and professional misconduct should be rewarded, for example, through enhanced funding for infrastructure, staff development, and student support initiatives. Historical misconduct cases, such as undetected contract cheating at the time of recruitment, warrant systematic review. Similarly, resistance by long-serving staff to performance reassessment or cognitive benchmarking should be addressed. Systemic reform must become a national priority in the pursuit of a circular, integrity-driven talent management ecosystem.

A qualitative and ethically grounded screening mechanism offers a more accurate alternative to current, numerically driven KPI assessments. The correct identification and support of 'quality manpower' is essential to ensure that national resources are directed toward genuinely critical contributors to nation-building. This approach reflects the principles of circular resource management. Revitalising the education system and preserving the nation's talent pool begins with a clear and honest definition of national needs – needs that are often vaguely articulated or overlooked – and aligning assessment systems accordingly.

Until such readiness is fully achieved, the performance evaluation framework for a national talent hub must place significant emphasis on literacy and foundational skills, which are central to maintaining robust national think hubs. Realising a circular economy depends on carefully executed groundwork that empowers talent across three essential dimensions: people, technology, and nature.

Public institutions and enterprises leading technological advancements must be informed of the challenges facing talent development and adjust their strategies to contribute meaningfully to national skilling initiatives. While schools and HEIs cultivate academic capabilities such as literacy, reading, writing, and synthesis of ideas, anchored in ethical practice, industry partners hosting interns can add value by fostering critical thinking through constructive, honest feedback. Complementing academic formation with real-world problem-solving skills enables learners to bridge the gap between theoretical concepts and practical application. Simultaneously, HEIs must continue to strengthen the foundational skills necessary for transformative capacities in educators, which are essential for systemic functionality and long-term national resilience.

As circularity requires intersected cross-sectoral sciences and arts, the misconception of agricultural sectors as a sector for the poor and uneducated (Miwil, 2024) must be rectified. Table 2 illustrates a situation of the modern agricultural practices of the

high-revenue nations and their dependency on agricultural production, depicted in the low percentage of GDP.

Table 2 Agricultural prominence

Country	*Agricultural land use (%)*	*GDP (%)*	*Agro-produce*
China	55	7.1	Rice, wheat, potatoes, etc.
Japan	20	1.0	Rice
Netherlands	66	1.5	Cereal
Poland	50	2.1	Rye, potatoes, grains
Denmark	65	1.0	Cereal, barley grains
UK	69	0.6	Wheat, barley, potatoes, vege
Australia	55	2.7	Cereals, grains, seeds, legumes
New Zealand		6.0	Meat, dairy, wine, dairy, fruits
Malaysia	16	7–9	Rubber, palm oil, cocoa
Indonesia	34	13.0	Palm oil, coffee, rice, cocoa
Thailand	46	8.8	Rice, palm oil, sugarcane, cassava

While farming remains an unpopular career choice among Malaysian youth, Indonesia offers a contrasting example with its dynamic cohort of young individuals committed to innovative and modern agricultural practices, an encouraging sign of transformative potential. This contrast reflects broader global patterns: nations with established track records in circular bioeconomy implementation, often from the Global North, have concurrently developed advanced agricultural systems. These countries have benefited from substantial intellectual achievements and economic diversification, reducing their dependence on primary agro-production. In this way, deagrarianisation resulted in the declining self-sufficiency of the rural household in subsistence food production, the relative reduction in employment in agriculture compared to other sectors of the economy, a reduction in the value of agricultural output per capita relative to other sectors of the economy, and the shrinking population of farmers living in rural areas (Drejerska, 2018). In contrast, economies with a high dependency on agriculture face considerable risks unless they adopt and deploy technologies that enhance climate resilience in production systems.

Before the full integration of Industry 4.0 components, such as the Internet of Things (IoT) and data analytics, can be realised in agriculture, a foundational requirement is the availability of comprehensive, accurate datasets (Ghazali, 2023). The revitalisation of smallholder agriculture, as discussed by Ghazali and Zbiec (2022), necessitates both parallel and sequential strategic actions. Improvements must be conceptualised and operationalised in tandem to be effective and inclusive.

Central to this transition is the cultivation of knowledge and competencies in fundamental areas such as plant science, soil health, climatic systems, and the stewardship of rich natural resources. These domains are critical enablers of a circular bioeconomy, positioning the sector as a space for intellectual engagement and ethical entrepreneurship. Within this framework, agriculture becomes a field for thoughtful individuals – those committed to creativity, knowledge-sharing, and integrity.

A circular talent management approach that adopts a needs-skills-alignment (NSA) paradigm serves as a strategic pillar for nation-building. It emphasises cognitive versatility and critical thinking while simultaneously reducing systemic inefficiencies, misconduct, and resource wastage. Ensuring that such systems are managed by competent, ethically grounded individuals is essential for establishing a sustainable and resilient bioeconomy, and by extension, a prosperous and future-ready society.

4 Conclusions

This research has explored the intersection between the circular economy approach and education systems, particularly focusing on talent management, agricultural practices, and the sustainable implementation of bioeconomy strategies. The findings highlight the importance of integrating circularity concepts within educational frameworks to foster creativity, critical thinking, and ethical practices in students, which are crucial for developing a workforce capable of driving a circular bioeconomy. By addressing the research questions, the study has shown that educational institutions can play a pivotal role in promoting sustainability, economic resilience, and innovation through their curricula and talent development programs.

The integration of circular economy principles in education systems, especially in developing nations, is crucial for creating a skilled workforce that can contribute to a more sustainable future. The research has emphasised the need for a cohesive talent management framework, which aligns educational outcomes with the growing demands of a circular bioeconomy. Furthermore, the study has illustrated the value of cross-sectoral approaches, where collaboration between education, industry, and agriculture can strengthen the circular economy model and contribute to the transformation of high-dependency agricultural nations.

Circularity, synonymously circular economy, is an impactful model for charting talent development as much as it empowers the industrial systems with gains by ensuring nothing goes to waste. A nation's readiness is one of the primary challenges in the circularity implementation. For nations grappling with youth thinking skills and education quality, the road to partake as an umbrella for circular economy resembling European Bioeconomy University takes extensive groundwork. Small changes to academic assessment, reskilling, and upskilling for talent-specific sectoral appropriation must be the navigation with the end in mind. In this regard, national needs-to-skill alignment (NSA) is not an option, given the differing regional economic activities. These steps require breaking into smaller milestones based on the reset targets. The strategy is to reduce further loss from big-budget-low-achievement, synonymous with waste. Not capitalising on the accurate avenues may result in another cycle of wastage, paralysing a nation already on the brink of collapse. Functionalising the talent hubs by reworking clearly defined needs sheds light on national prosperity of global relevance, reviving HEIs' roles as the reservoir of modern, creative solutions beyond conventionality.

While this study provides valuable insights into the integration of circular economy principles within education systems, several limitations must be acknowledged. First, the research primarily focuses on the theoretical and conceptual aspects of circularity in education, with limited empirical data from real-world case studies, especially from developing countries. The application of circular economy principles in diverse educational contexts may vary significantly, and the findings may not be fully

generalisable across all nations or regions. Additionally, the study's scope was confined to certain key sectors, such as agriculture and bioeconomy, which may not fully capture the breadth of circular economy applications across other industries. Future studies could benefit from primary data collection and case-specific research to further explore the practical implementation of circular economy concepts in education systems globally.

Moving forward, it is evident that for a transition towards a circular bioeconomy, educational systems must embrace interdisciplinary approaches that foster innovation, ethical entrepreneurship, and sustainability. Aligning education with the principles of circularity, particularly through reskilling and upskilling initiatives, will be instrumental in addressing the challenges faced by developing nations and ensuring the long-term success of the circular economy.

Declarations

The authors utilised AI-based language editing tools to enhance the clarity and grammar of the manuscript. No AI-generated content was included in the research findings or interpretations.

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