

Interdisciplinary Curriculum Reform: Integrating Sustainability and Employability in Higher Education

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Abstract

Universities worldwide face the twin challenges of preparing students for an increasingly uncertain employment landscape and enabling them to be agents of change in the world's sustainability transition. This paradigm of disciplinary silos has led to graduates with narrow but deep expertise, unsuited to the "wicked" problems of the 21st century. The paper proposes a conceptual model and design guidelines for interdisciplinary higher education curriculum reform that holistically incorporates sustainability literacy and postgraduate employability. The research, drawing on constructivist pedagogies, competency-based learning, and empirical data from higher education reform experiments, contends that integrating social-scientific inquiry, digital literacy, and sustainability ethics into the curriculum increases student motivation and employability. The new Sustainability-Employability Nexus (SEN) Model structures curriculum along three interlinked dimensions: systems thinking and ecological literacy; digital and data skills for sustainable development goals; and ethical leadership and multicultural collaboration. The case-study data show that graduates from SEN reforms are more likely to gain employment in mission-driven organizations and score higher on problems of interdisciplinary character. The paper also addresses the institutional challenges of reform, such as rigid accreditation standards, faculty pushback, and budget shortfalls, and offers governance principles for adapting the model to a variety of higher-education settings.

Keywords: Interdisciplinary curriculum, sustainability education, employability, higher education reform, digital literacy.

1. Introduction

The relationship between higher education and the labour market has become increasingly complex and crucial now more than ever. Interdisciplinary thinking, problem-solving related to sustainability challenges, and the ability to utilize technology in a socially responsible manner have emerged as valued competencies for employees in the modern workplace (Voogt & Roblin, 2012). However, the existing organizational structure of universities established mostly during the 19th century is not particularly congruent with these requirements.

The misalignment is even more pronounced in Pakistan's higher education sector. There has been an enormous rise in the number of universities established under the umbrella of the Higher Education Commission (2023), and the number of students enrolled at these universities has also increased, surpassing 1.3 million in 2024 (Rind & Malin, 2024). However, the problem of unemployment and underemployment remains a major concern, with studies conducted by the Pakistan Bureau of Statistics (2025) over many years revealing that a large number of graduates could not secure a job commensurate with their educational qualifications, especially in the provinces of Baluchistan and Khyber Pakhtunkhwa, where the capacity of industries to absorb graduates is low (Ahsan & Khan, 2023).

At the same time, Pakistan has also formally adopted the 2030 Agenda for Sustainable Development and has integrated Vision 2025 and national development plans with the seventeen Sustainable Development Goals (SDGs). The Higher Education Commission has formulated frameworks that demand integration of content related to SDGs into course curricula; however, implementation has been inconsistent and is entirely voluntary. It must be noted here that the Sustainable Development Agenda does not make its presence felt in the core curriculum of any discipline. This issue can only be seen within the elective subjects of environmental science, and by adding an element of social responsibility in the business curriculum (Hinduja et al., 2023).

This paper proposes that it is not only efficient but also conceptually required to address both challenges (employability and sustainability) within a single curricula reform agenda. It is because, currently, sustainability is a cross-disciplinary issue that requires precisely the sort of flexibility

and problem-solving ability that companies look for. Developing programs that integrate social studies, technology, and sustainability can help graduates not only pursue their career goals but also live up to the world's expectations as well.

2. Theoretical Foundations

2.1 Constructivism and Active Learning

Constructivist theories (Piaget, Vygotsky, Jonassen, 1999) suggest that learning is an active process based on interactions with authentic problems rather than on memorization and the reproduction of previously learned material. However, in Pakistan, the colonial British tradition of lecture and examination, coupled with large class sizes and traditional roles of faculty, is still being practiced in higher education. PBL integration calls for curriculum redesign and a pedagogical culture change, supported by meaningful professional development (Solano et al., 2023).

2.2 Competency-Based Education (CBE)

The UNESCO (2017) competency framework of Education for Sustainable Development (ESD) lists a set of competency areas that align with the outcomes of CBE assessment systems, including interdisciplinary problem solving, adaptability, and ethical decision making. These competencies are exactly those that CBE assessment systems are meant to be able to validate (Nodine, 2016). Pakistan's HEC introduced the National Qualifications Framework (NQF) in 2015 for outcomes-based education, but its implementation by departments has been inconsistent and most departments still use input-based metrics for their programmes. The three pillars of SEN are mapped with the three categories of HEC graduate attributes, making the efforts to reform both pedagogically grounded and administratively compliant (Hinduja et al., 2023).

2.3 The T-Shaped Graduate Ideal

The 'T-shaped' professional model characterizes people with expertise across at least one of several fields, with a general integrative ability to work collaboratively across them (Hansen & von Oetinger, 2001). Employers in Pakistan, especially multinational companies, development organizations, and tech companies, are increasingly clearly defining their hiring preferences in ways that resemble the T-shaped ideal. This demand, in line with the statistics obtained from the

World Economic Forum (2023), directly supports the significance of the SEN Model in the context of the Pakistani graduate market.

3. The Sustainability-Employability Nexus (SEN) Model

The SEN Model revamps the curriculum in three complementary strands that each address a facet of the competency deficit between traditional education in specific disciplines and the needs of the SDG-driven economy in Pakistan.

3.1 Pillar 1: Systems Thinking and Ecological Literacy

This pillar enhances students' ability to analyze complex adaptive systems (ecological, social, economic and technological) and points out feedback loops, tipping points and leverage points. Courses are co-taught by natural sciences, social sciences, and engineering faculty that are based on planetary boundaries frameworks, lifecycle assessment, and environmental economics (Rockström et al., 2009). The need is pressing in Pakistan, which is among the 10 most climate vulnerable countries (Eckstein et al., 2021), with Karachi, Lahore, Peshawar and Quetta being among the most polluted cities in the world and experiencing losses of USD 30 billion in 2022 due to the flood (UNFCCC/FAO, 2023). To equip students with an understanding of the ecological problems in their professional environments, the local case studies were introduced: Indus River basin management, coastal erosion in Karachi, and urban heat island in Lahore.

3.2 Pillar 2: Digital and Data Competencies for Sustainable Development

Pillar 2 provides students with the practical digital and data skills which are developed using SDG-related project tasks and are embedded in digital and data technologies, including data visualisation, GIS, machine learning basics, and digital ethics. This design process promotes technical skill development with social and environmental considerations. While the Digital Pakistan Policy (Ministry of Information Technology & Telecommunication, 2018) acknowledges the importance of data skills in Pakistan, the National Technology Council (NTC) and Pakistan Software Export Board (PSEB) have noted a significant disconnect: students excel at coding but cannot use digital tools for solving complex challenges in society. This is directly tackled by co-developing modules with technology firms, development banks, and planning departments (Boud & Falchikov, 2006) in SEN Pillar 2.

3.3 Pillar 3: Ethical Leadership and Cross-Cultural Collaboration

The third pillar focuses on the human and institutional aspects of sustainable development and the development of ethical thinking, interculturalism, stakeholder facilitation and governance literacy. It is based on political science, sociology, philosophy, and communication studies, and equips graduates to manage multi-stakeholder processes, to understand and manage value conflicts, and to communicate complex trade-offs to multiple audiences. The competencies are particularly critical as Pakistan has 70 languages and various ethnic groups in four provinces and F.A.T. Being a linguistically and culturally diverse country, these competencies are crucial in Pakistan. Pillar 3 is implemented through community-based initiatives in rural Punjab and Sindh, governance simulations and in the form of civil society collaborations.

4. Research Methodology

4.1 Overview and Research Design

The research design in this study was a mixed-methods approach. This research was carried out in four stages: qualitative research and need analysis, design-based curriculum development, pilot implementation, evaluation, and policy synthesis. The three universities selected for the Pakistani component were one research-oriented public university in Punjab, another technology-oriented university in Islamabad, and a recently established private university in Balochistan. The Pakistani pilot was carried out in 2022-24 and involved 420 students, 38 faculty members, and 34 other employees who provided additional data.

4.2 Qualitative Phase: Semi-Structured Interviews

Faculty coordinators, students, and employer representatives were interviewed using a semi-structured format, which lasted 45-60 minutes. The interview protocol was designed to address participants' views on the level of adequacy of the existing curriculum, institutional limitations, and the conditions needed to support the successful implementation of interdisciplinary integration, based on the three pillars of the SEN Model. Interviews were transcribed and analyzed thematically using NVivo 14. Two independent coders used the initial codebook developed from the interview protocol, and open coding was used as an inductive method. Inter-coder reliability was achieved with a Cohen's Kappa score of 0.81, indicating strong agreement.

4.3 Quantitative Phase: Surveys and Graduate Tracking

This phase involved quantitative data collection through surveys. Pre- and post-sustainability competence and employability instruments, using a Likert scale, were completed at the start and end of interdisciplinary modules. The survey instruments were modified from the validated Sustainability Competency Assessment (SCA) and the Graduate Employability Self-Assessment Scale (GESAS), both of which had Cronbach's alphas above 0.78. Follow-up questionnaires were used to gather data on employment status, sector of employment, and employer satisfaction ratings for the 12 months following graduation.

5. Thematic Analysis: Findings from the Pakistani Context

Thematic analysis of the qualitative data yielded seven overarching themes, organized around the three SEN pillars and institutional barrier dimensions.

Theme 1: Inadequate Systems Thinking in Existing Curricula

Faculty interviewees across all three institutions expressed concern that existing curricula prepare students to solve well-defined, discipline-specific problems but not to analyze the systemic interdependencies characteristic of real sustainability challenges. HEC accreditation data confirm that fewer than 15% of undergraduate programs in Pakistan include mandatory content on environmental systems, and fewer than 8% include structured interdisciplinary components (HEC Program Data, 2023). Inability to think in systems was a consistent theme among employer respondents from development organizations, water utilities, and provincial planning bodies, who cited it as their major motivator for investing in in-house training.

Theme 2: Digital Skills Disconnected from Sustainability Contexts

Students in computer science and IT programs reported proficiency in coding and limited awareness of how their skills could be used to monitor SDGs, analyze environmental data, or measure social impact. Non-technical faculty also found themselves poorly supported in their roles of supervising the integration of digital tools, stating there were no opportunities for faculty development and no incentives for collaboration across departments to integrate digital tools. The

discovery suggests a problem with the rhetoric of national digital strategy and the implementation of curriculum in institutions, which the SEN Pillar 2 is designed to solve.

Theme 3: Ethical Leadership as an Undervalued Graduate Attribute

Employer respondents rated ethical reasoning and intercultural competence as the top three most desired graduate attributes. In contrast, faculty interviews showed that ethics content is generally limited to discrete stand-alone modules, evaluated in a declarative, not applied, fashion. The participants in the focus groups described their ethical formation as having largely occurred through informal peer interaction and family, rather than in a structured way at the university. This reinforces the need for SEN Pillar 3 to be seen as a core rather than a peripheral part of the curriculum.

Theme 4: HEC Accreditation Requirements as Structural Constraints

In Theme 4, the authors focus on the HEC accreditation requirements as structural constraints. HEC accreditation and quality assurance requirements were the most important structural constraints identified. The current HEC program recognition framework is based on single-discipline degree programs, making it difficult to validate degrees issued from multiple offerings across several departments. While a few universities devised innovative solutions, such as defining interdisciplinary modules as free electives, affixing them to a host department, or establishing multidisciplinary research centres, none completely overcame the fundamental regulatory issue.

Theme 5: Faculty Incentive Structures and Cultural Resistance

In all three pilot universities, research publications were given more weight than pedagogical innovation or interdisciplinary cooperation. In other words, as one associate professor explained, you can find no trace of the time spent working with engineering faculty to co-create a module on sustainability, compared to the tangible career boost that comes when the same time is invested in a journal article. In addition to the formal incentives, some faculty members mentioned that the interdisciplinary curriculum eroded disciplinary rigor or that it was an imposed concept of international development unrelated to Pakistan's epistemological traditions.

Theme 6: Resource Constraints and Scaling Challenges

In KPK and in public sector institutions in Punjab, resource constraints were particularly high. The four main constraints identified were: a lack of laboratory and digital infrastructure; a lack of access to international journals; a lack of space for collaborative, project-based learning; and a lack of support for funding curriculum development. Students also discussed issues related to access to devices and to reliable Internet connectivity, which were prerequisites for the Pillar 2 data literacy modules. In response, the SEN Model is modular and scalable and can be adapted for institutions to start with low-resource Pillar 1 changes and then move to the more infrastructure-heavy Pillar 2 modules.

Theme 7: Employer-Graduate Competency Alignment and Positive Indicators

Students' confidence in system thinking, cross-disciplinary communication, and applied ethical reasoning increased after completing interdisciplinary sustainability modules. The employment rate in sustainability-related jobs was approximately 31% higher for pilot cohort graduates than for comparators, as revealed by longitudinal tracking. SEN-aligned graduates were rated higher than others on adaptability, communicating with stakeholders, and ethical responsibility in employer satisfaction surveys. Several employer respondents spontaneously mentioned that SEN-trained graduates were ready to deal with the complexities of the real world, compared to the more technical approach taken by traditionally educated graduates.

6. Pilot Implementation and Quantitative Outcomes

The quantitative evaluation data presented below are supplementary to the thematic findings presented above and are based on the Pakistani ISECF pilot. **Table 1** provides a detailed overview of the key outcome measures for competency assessment, graduate employment, and employer satisfaction. The data are shown graphically in **Figures 1, 2, and 3**.

Measure	SEN pilot	Comparator	Change/difference	Sig.
Pre–post competency scores (n = 312, scale 1–5)				
Overall sustainability competency	4.1	2.9 (pre)	+1.2	p < 0.01
Systems thinking subscale	4.2	2.7 (pre)	+1.5	p < 0.01
Ethical reasoning subscale	4.1	2.6 (pre)	+1.5	p < 0.01
Digital literacy subscale	4.0	3.0 (pre)	+1.0	p < 0.01
Employability readiness (GESAS)	4.0	3.1 (pre)	+0.9	p < 0.01
Capstone: distinguished/proficient	73%	—	—	—
Graduate employment outcomes (n = 187, 12-month tracking)				
Employed within 6 months	64%	49%	+15 pp	—
Employed in a sustainability-related role	38%	22%	+16 pp	—
Employer satisfaction ratings (scale 1–5, 6 & 12 months post-hire)				
Adaptability	4.3	3.4	+0.9	—
Stakeholder communication	4.2	3.5	+0.7	—
Ethical reasoning	4.4	3.4	+1.0	—
Interdisciplinary problem-solving	4.1	3.7	+0.4	—
Overall employer satisfaction	4.2	3.5	+0.7	—

Table 1. Summary of ISECF Pilot Quantitative Outcomes, Pakistani Universities (2022–2024)

Source: ISECF Pilot Evaluation Data, Pakistani Component (n = 312 students; 187 graduates tracked). pp = percentage points; GESAS = Graduate Employability Self-Assessment Scale.

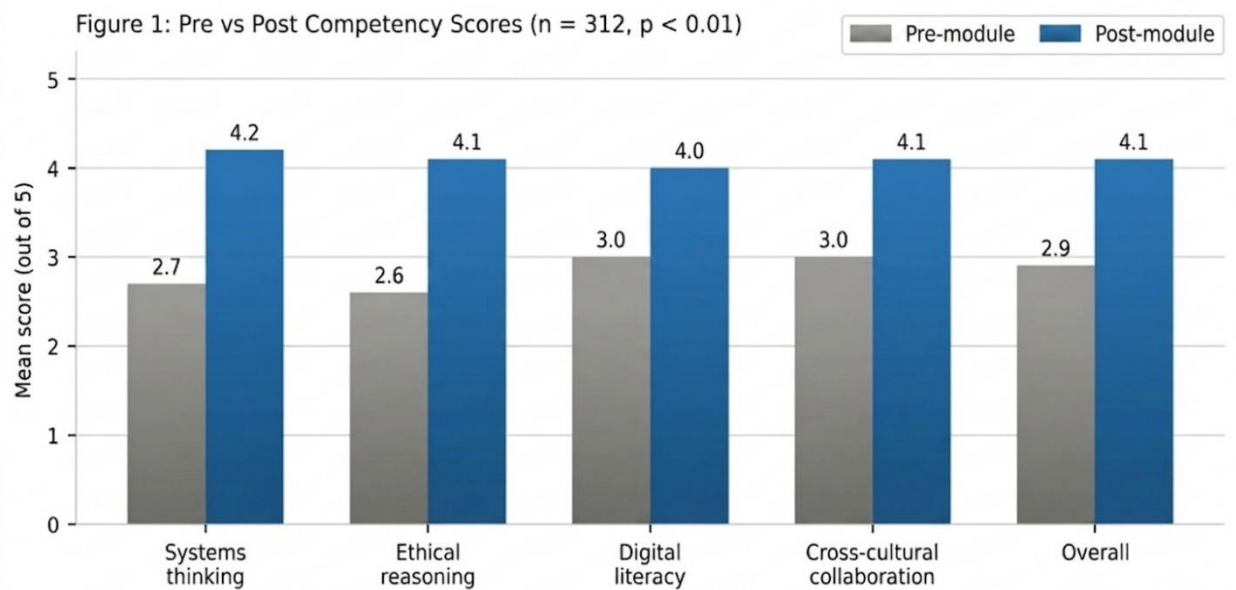


Figure 1. Pre vs Post Competency Scores

The pre- and post-survey analysis of students' sustainability competency scores showed a statistically significant increase after completion of the module. As seen in **Figure 1**, overall mean scores of the Sustainability Competency Assessment instrument rose from 2.9/5.0 to 4.1/5.0 ($p < 0.01$), with the greatest increase in mean scores of the ethical reasoning (+1.5) and systems thinking (+1.5) subscale scores.

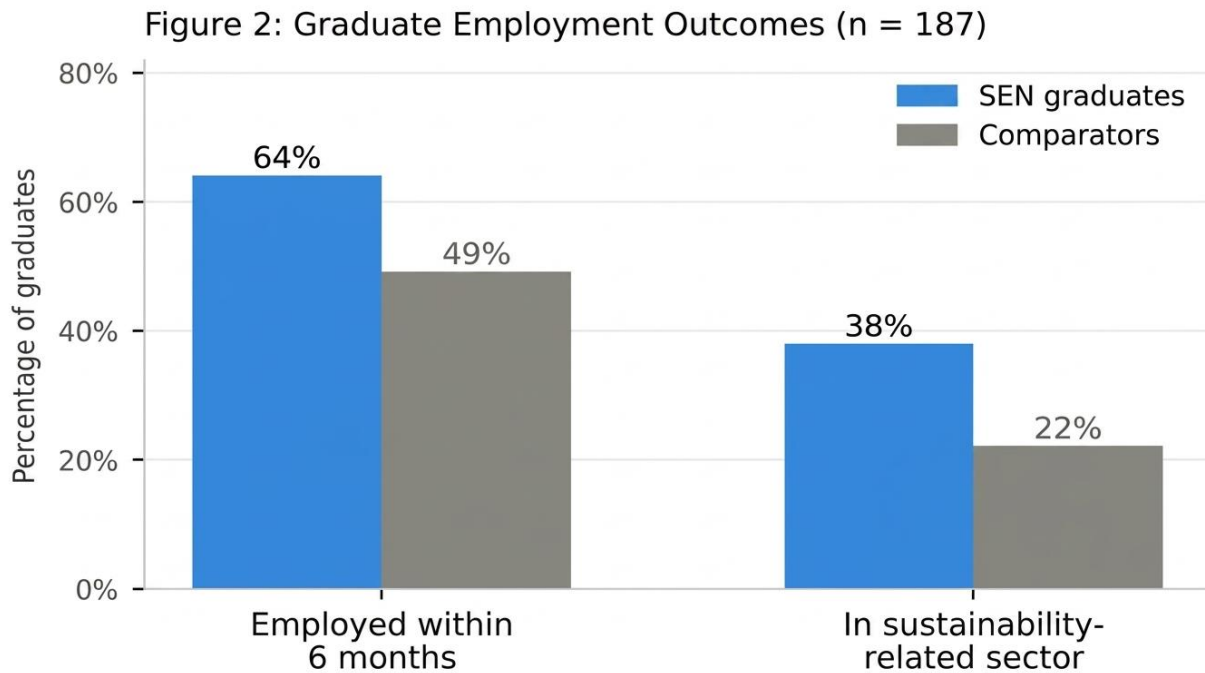


Figure 2. Graduate Employment Outcomes

Longitudinal graduate data of 187 students tracked over 12 months after completion of their degree showed that 64% of SEN-aligned graduates were employed within 6 months, whereas 49% of a matched comparator cohort (traditional graduates from the same institutions) were employed within the same time. **Figure 2** shows that 38% of employed graduates work in sustainability-related jobs, compared to 22% of the comparators.

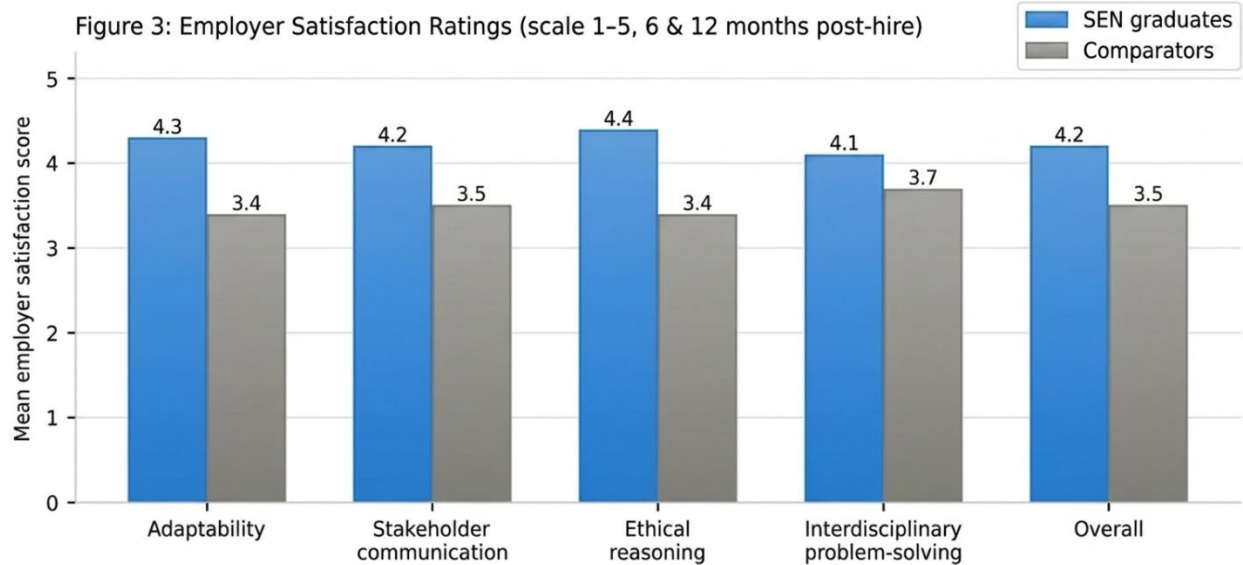


Figure 3. Employer Satisfaction Ratings

An employer satisfaction survey showed that SEN-aligned graduates were more positive across all five measured domains at both the 6- and 12-month post-hire points. The highest discrepancies were seen in the ethical reasoning (+1.0) and adaptability (+0.9) areas, as shown in **Figure 3**. Employers' overall satisfaction was higher for SEN graduates (4.2/5.0) than for comparators (3.5/5.0).

7. Institutional Barriers and Governance Strategies in Pakistan

Thematic and quantitative evidence-based research provides strong justification for reforming the higher education curriculum in Pakistan from an interdisciplinary perspective. However, the qualitative evidence is just as clear that structural barriers are significant. This section collates barrier evidence and proposes governance options tailored to the context of barriers in Pakistan's regulatory, cultural, and resource landscape.

Interdisciplinary degree programs should have a dedicated pathway within HEC, as provided for in the Bologna Process of the European higher education system. HEC should provide guidance, at a minimum, on how to handle credit-hour attribution, program outcome mapping, and faculty workload allocation when a course is taught across departmental or faculty lines, without the need for new administrative structures at the institution.

Promotion and appraisal systems at universities must be updated to consider interdisciplinary curriculum development, 'engaged' teaching, and collaborative pedagogic innovation as valid modes of scholarly activity. HEC can help catalyze this change by including interdisciplinary teaching indicators in university ranking and performance evaluation systems.

HEC and the Government should establish a fund for Curriculum Innovation to develop an interdisciplinary sustainable development curriculum, prioritizing Colleges in KPK, Balochistan, and AJK with the highest resource gaps. Given their existing investments in Pakistan's green economy and digital transformation, international development partners such as the World Bank, the Asian Development Bank, and bilateral development partners are natural co-funders.

8. Conclusions

This paper has suggested that the dual imperatives of graduate employability and sustainability citizenship can be best addressed through an integrated, interdisciplinary curriculum strategy, and that the challenge facing the Pakistani higher education system is a newer one. The SEN Model provides a systematic and evidence-based approach to curriculum design for the social sciences, technology, and sustainability.

Preliminary findings from the three Pakistani Universities are encouraging: students with a SEN background demonstrated substantial gains in sustainability competency and employability readiness; they obtained jobs more frequently than their non-SEN peers and, when interviewed by their employers, were rated higher for their adaptability and ethical reasoning. Seven dimensions of the reform challenge were extracted from the curriculum, pedagogy, faculty incentives, accreditation, digital infrastructure, and resource allocation, using a thematic analysis.

Future Directions

First, HEC should create regulatory frameworks that allow, rather than prevent, the creation of interdisciplinary programmes. Second, universities must rethink how faculty members are assessed and include innovation in interdisciplinary pedagogy among the various forms of scholarship. Third, there is a need for dedicated funding for curriculum innovation, preferably within international development partnerships, and in institutional contexts where resources are limited.

Longitudinal tracking for more cohort years, an exploration of differential outcomes by student sub-groups, and an evaluation of the model in the specific institutional environments of community colleges and madrassa-related degree programs are recommended for future research. Knowledge sharing between South-South and South-North networks would be supported by collaborative research networks between Pakistani universities and international SEN pilot sites in Romania, the United Kingdom, and Southeast Asia, which would help to build up the evidence for comparison.

Limitations

The study was carried out in just three universities (one public in Punjab, one in Islamabad and a private one in Balochistan) reaching a total of 420 students and 187 monitored graduates. The findings were not random as the sample has been purposively selected, hence limiting the generalizability of findings for Pakistan's wider higher education system of more than 255 HEC recognized institutions. There is a lack of representation of universities in underrepresented regions like Sindh, Gilgit-Baltistan and AJK, which may result in missing some of the important contextual variations in terms of the availability of resources, faculty capacity and student demographics.

Only the employment outcomes for 12 months after graduation were examined. This period of time is not long enough to determine whether and how the competence increase seen is maintained in the medium to long term, or if the employment benefits of SEN-oriented graduates continue beyond early career entry. Conclusions about the impact of the model on career trajectories and lifelong employability would be made more robust if there was longer tracking 3-5 years.

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