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**Integrating Sustainable Development Goals into Higher Education Curricula:
Impacts on Sustainability Knowledge, Student Engagement, and Graduate
Competencies**

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Abstract: In this study, the integration process of Sustainable Development Goals (SDGs) into higher education (HE) education, and the influence of this integration on sustainability knowledge, engagement and qualified competencies of graduates, will be of focus. A questionnaire, interviews, focus group and document analysis was used to gather information from 976 participants in a 20 institution cross sectional design. Descriptive statistics, multiple linear regression and SEM (structural equation modeling) were used in analyzing the statistical data. The findings show that SDG integration has a strong predictive effect on students' competency scores, where establishing SDGs in the school curriculum ($\beta=0.45$, $p<0.001$) and faculty readiness ($\beta=0.38$, $p<0.001$) have the greatest predictive effects; the regression model shows that the variation in students' scores in this competency is 74.2% of the influence of the analyzed variables. SEM indicated good model fit (CFI = 0.97, RMSEA = 0.044). The institutions that had comprehensive integration of SDG content had 28.5% more sustainability knowledge and 24.7% higher level of student engagement with sustainability; they had 22.9% increased levels of environmental responsibility and 19.8% increased employability competencies gained by their graduates compared with the institutions that had limited SDG content. Further, 74.8% of the institutions included content about sustainability in their curriculum and 71.6% of the students participated in sustainable development projects. What makes this work new is the use of multiple levels of empirical effects of curriculum design, teaching, and institutional support as interrelated predictors of sustainability outcomes. We feel it necessary to embed the SDGs in educational programmes; offer support at institutional level and build capacity within the faculty in order to deal with complex global issues. The results of the research will provide some practical specific recommendations to policy writers and teachers who want to enhance curricula and build sustainability capacity in college students.

Keywords: Sustainable Development Goals (SDGs), Higher Education, Sustainability Education, Student Engagement, Graduate Competencies

Introduction

Climate change, biodiversity loss, social inequality/economic instability are global challenges that have also stressed libraries, and this is a challenge that would be new for higher education institutions to raise and prepare students to meet and face the multifaceted sustainability challenges they will likely be presented with in the future. So, the 2030 Agenda for Sustainable Development has emerged into the daylight and 17 Sustainable Development Goals (SDGs) have turned it into a large blueprint for the world's sustainable development (Sayed, 2015). The Education 2030 Framework for Action clearly asks educational systems to engage sustainability in all levels of schooling (Sachs-Israel, 2016). Integration of SDGs in the higher education institution in the curricula, research and practice puts SE at the heart of preparing students with a multi-disciplinary education, supported by critical thinking and ethical convictions for a more sustainable world. It is widely recognized that ESD is needed; but thus far, its implementation is inconsistent and incomplete from institution to institution. Although high-level policy initiatives aim to redirect tenured universities towards more sustainable teaching, these changes are difficult to make in actual classrooms because the higher ed institution is structured in such a way that faculty members are not prepared to implement pedagogies related to sustainability in their classes (Franco et al., 2019). Furthermore, the literature available is predominantly focused on a few individual case studies and/or single-institution based studies, highlighting a lack of awareness of the effects of broader institutional, systematic SDG integration strategies on student outcomes and institutional capabilities (Dutta et al., 2026). Hence, a more empirical approach focusing on interactions between the curriculum design, teaching mode, teacher qualification and institutional supports for the development of sustainability competency should be further researched.

To fill this, we have carried out a full and mixed methods study in 20 different HEIs, exploring how the relationship among SDG curriculum integration and important educational outcomes. The main thesis of this study was that a strategic approach, including the integration of the SDG content in the programs, significantly enhances students' knowledge of sustainability and interdisciplinary learning throughout the program, increases engagement and employability as a graduate, and boosts readiness among faculty and support from the institution. The overall goal was to shift the normative call for change to a discussion of empirical evidence that can be used to guide evidence-based policy, program, and faculty development efforts. This is a triple contribution of this work. It offers a thorough multidimensional empirical assessment that was evaluated across multiple institutions that captures the complexity of ESD in a broader higher education system addressing official accrediting bodies as well as societal expectations for students with a sustainability capacity. (Gnankob et al., 2026); Second, it creates and testifies a series of composite indexes (like SDG Curriculum Integration Index and Graduate Sustainability Competency Index) which allow a structured and quantifiable comparison of institutional progress. Thirdly, it applies highly accurate statistical model such as multiple linear regression, and structural equation modeling (SEM) in determining the relationships of Curriculum Integration directly with students' involvement and sustainability results as well as the relationships of Curriculum Integration directly with students' involvement and

sustainability results with the involvement of faculty readiness. This method enables us to define the most influential leverage points to allow intervention, whilst descriptive and single variable analysis would not give this type of in-depth analysis that would be necessary. The literature review in Section 2 entails reviews of the past research on how ESD and SDG can be integrated in higher education. Section 3 presents the method for investigating the issue followed by results of the research presented in Section 4. The results of the research are presented in Section 4 and a discussion of the results and conclusions that could be drawn from them is presented in Section 5. The paper ends in section 6. In Section 3 the mixed methods research design, methods of participant recruitment, development of data collection tools, and the collection of a series of statistical analyses utilized are discussed. The empirical findings are reported in Section 4, comprising mainly descriptive statistics, regression results as well as model fit indicators in an SEM. The implications of these findings for policy, curriculum design and faculty development (along with the limitations of the study) are discussed in section 5. Key Insights and recommendations for future research and practice (Section 6) summarises the key findings and recommendations.

Literature Review

Over the last three decades, the idea of Education for Sustainable Development (ESD) has grown in size and significance and transformed from being just another educational issue to becoming an integral part of higher education policy discourses. The reorientation of curricula to ESD has been clearly indicated in the Global Action Programme on ESD document of UNESCO (Buckler & Cree, 2014), and echoed by the SDGs and the 2030 Agenda. This evolution has spurred several academic research projects around ways to design institutions that are most conducive to reaching fuzzy visions of environmental sustainability in concrete ways for sustainable pedagogies and evidence of learning. Facilitating more in-depth learning and competency development to embed sustainability within courses and course syllabus has been emphasized (Wu & Shen, 2016) and this includes embedding, rather than just teaching sustainability in different courses, also in an integrated, systematic way. In several studies, the mechanism of the impact of integrating SDG in outcomes of students has been studied. For instance, if students' curricula are developed in sustainable ways, they will become more capable of grasping the interconnections between the environmental, social, and economic (VPE), as found by Wals and Benavot (2017). In addition, interdisciplinary sustainability course investigations have shown that the course content could significantly increase students' problem-solving skills in groups as well as their capacity for ethical considerations—which are essential in tackling wicked sustainability problems (Horn et al., 2023). This finding is in line with other theoretical attempts to emphasize competence-based education in which the learning outcomes are defined and measured in competencies, which is consistent with the SDG that defines or measures them. However, the mediating effect of faculty readiness has been demonstrated less in empirical literature. While a handful of studies have found positive relationships in attitudes and skills of faculty members towards SDGs, and in faculty exposure to sustainability pedagogies with inclusion of the issues in teaching, the links between the faculty skills and attitudes and potential improvement in student learning have been little studied (Owusu-Agyeman, 2021). Furthermore, previous studies tend to have methodological

limitations such as studies based on a single institution in a case study, too small of samples and lack of validated composite indicators to produce sustainability outcomes. For example, even if the studies presented discussed integration of SDGs may be needed, many of them have been qualitative and others lacked efficacy, quantitative analysis and did not include more than one level of institutional change that makes them applicable to broader application (Lozano et al., 2022; Serafini et al., 2022). The present study attempts to fill in these gaps with its empirical design from various institutions and settings and by comprehensively analyzing the interdependence of the predictors of sustainability competency. Our study is ground-breaking in that it looks at the entire study of ESD not just one aspect, including curriculum design, teaching practices, faculty readiness, and the institutional support. Creating composite indices, such as the SDG Curriculum Integration Index and the Graduate Sustainability Competency Index, offers a framework and approach that can be applied in a replicable way to measure progress in various institutional settings.

Methodology

The technical aspects of the research design, data collection and data analysis methods used to test the SDG integration in the HE curricula is shared. A multi-level modelling methodology was designed to format the different types of influences on the development of sustainability competency, enabling the comprehensive assessment of the interrelatedness of the different levels of curriculum design, faculty readiness, student involvement and institutional support.

Research Design and Sampling

Regarding quantitative component of research, survey method was used and for qualitative research, interview and document analysis were employed to get insight from Mixed Method Cross Sectional Research. Such an approach enabled us to synthesise information from a variety of data sources and filters, and to gather both broad range and depth of information on integration patterns and factors. This study was conducted in 20 purposefully selected Higher Education Institutions (HEIs) with diverse geographic, institution size, location of institution (public or private), and involvement in ESD initiatives. Out of these institutions 1000 participants were selected as stratification random sampling for even distribution of participants across the four Stakeholders groups which are Undergraduate Students, Postgraduate Students, Faculty and Academic Administrators. It was significant for depicting the diverse viewpoints at various institutional levels, which can experience and react to the integration of SDGs differently.

Data Collection Instruments

Four complementary instruments were used to collect primary data. Respondents were all provided with structured questionnaires with a total of 48 items pertaining to the respondent's demographic characteristics, awareness of SDGs, sustainability knowledge level (measured through the use of a 15 item quiz), level of perception of curriculum integration, methodology used/experienced, level of students' participation in sustainability activities, learning outcomes, including those of employability skills related to sustainability, and others. Items pertaining to attitudinal variables were asked on a five-point likert-type scale while those used for knowledge

assessment were in multiple choice format. Second, to delve deeper into barriers and enablers of SDG integration, 40 faculty members and curriculum developers were interviewed semi-structured. Third, eight to ten students took part in six focus group discussions, collecting experiential stories on learning about sustainability. To fill the identified gaps, education institutions involved in the project were subjected to curriculum document analysis whereby the documents, based on their content, were systematically categorized in terms of SDG-related content, interdisciplinary aspects, experiential learning aspects. Secondary data were collected from or about the institutions through institutional reports to add more context to the sustainability strategy, allocation of institutions' resources, and external accountability mechanisms in each institution. This multi-source approach lent additional validity to the results because not only was self-reported data involved but more than one source was involved in the data collection process.

Variables and Composite Indices

The variables collected were related with several constructions. Demographic factors included academic level (undergraduate/postgraduate/faculty and administrators), gender, age and discipline. To assess awareness the participants were asked to recognise the right number of SDGs and asked to recall three of them. Assessment of sustainability knowledge was determined by providing a knowledge test on sustainability, which contained 15 multiple-choice questions on the topics of the environment, social and economic aspects of sustainability. Operationalisation of the level of curriculum integration of SDG was carried out through document analysis by calculating the percentage amount of courses within a programme which explicitly contain SDG content. Their teaching methods were divided into the traditional lecture approach, project approach, service-learning and interdisciplinary approach and numbered on a Likert scale. To enable some amount of standardization in comparison of institutions, 7 composite indices are formed. Each country's SDG Curriculum Integration Index is a weighted total of four indicators, all expressed as percentages on a scale of 0-100: how many of the total number of courses studied had content relating to the SDGs, the depth of discussion (mention versus analysis), the presence of interdisciplinary courses and the inclusion of experiential learning elements. Sustainability Knowledge Score" was the score achieved for answers that were correct in the 15 questions of the quiz. The Student Engagement Index values were the frequencies from involvement in sustainability-related projects and events on campus and in the local community. The Faculty Readiness Index was developed by incorporating the four components (i.e., self-reported familiarity with the SDGs, having attended the ESD training, self-reported confidence in teaching SDG related content, using active teaching pedagogies). The indicator for institutional sustainability, Institutional Sustainability Index, revealed that there was an institutional sustainability plan, an office of sustainability & SDGs were included in institutional mission statements. Environmental Responsibility scores were derived from the number of times the pro-environmental behaviors and attitudes measured on a Likert scale were reported. Finally, the Graduate Sustainability Competency Index was built based on graduate self-perceptions of enhancement in the five competency areas: Systems thinking, critical thinking, Interdisciplinary collaboration, Ethical reasoning, Employability, which were supported with employer feedback where possible. All

the indices were assessed for their internal consistency by Cronbach Alpha reliability analysis with the $\alpha \geq 0.70$ as the desired cut-off point. The alpha scale obtained is acceptable with values between 0.74 (in FRI) and 0.89 (in GSCI).

Data Preprocessing

The data were systematically preprocessed. The responses that were not completed were excluded (24 of 1000, 97%) and any missing responses on a continuous variable were imputed with the median to maintain a large sample size without compromising the results of the data analysis. The data was coded and checked for categorical variables in special fashion to prevent any errors in the coding. No value was identified as an outlier: The interquartile ranges (IQR) method was used to detect the outlying value of the cases, any values below $Q1 - 1.5 \times IQR$ and above $Q3 + 1.5 \times IQR$ were marked and checked for data entry error but no value was excluded from the data as an outlier.

Statistical Analysis

The following analytical approach was used and each of the research questions was addressed: Descriptive statistics comprised of means, standard deviations, frequencies and percentages were used for summarizing the sample characteristics and institutional integration. Secondly, a Pearson correlation analysis was carried out to explore the associations between the composite indices and to check for possible multicollinearity issues. After that a multiple linear regression analysis was used to determine the predictors of the graduate level of Sustainability Competency with the four indices listed below being inputs. Four indices listed above were then used in a multiple linear regression analysis to identify the predictors of Sustainability Competency at the graduate level. This regression model has been defined as:

$$GSCI = \beta_0 + \beta_1 SCII + \beta_2 FRI + \beta_3 SEI + \beta_4 ISI + \epsilon$$

Linear relationship: $\epsilon = b + \beta_1 * GSCI + \beta_2 * SCII + \beta_3 * FRI + \beta_4 * SEI + \epsilon$ where "GSCI" is the Graduate Sustainability Competency Index, "SCII" is the SDG Curriculum Integration Index, "FRI" is the Faculty Readiness Index, "SEI" is the Student Engagement Index, "ISI" is the Institutional Sustainability Index, b is the intercept, and ϵ is the error term, with the regression coefficients β_1 , β_2 , β_3 , and β_4 . Standardized beta weights were used to measure (relative) strength of predictors. The model was assessed by examining the R^2 and adjusted R^2 values and to determine if there were any multicollinearity issues, variance inflation factors (VIF) were valued with < 2.5 . To assess for differences in groups (institutions with different levels of SDG integration: comprehensive, moderate, limited and between undergraduate and post-graduate students, science disciplines versus humanities disciplines), AnaVotest (one-way ANOVA) and independent sample t-tests were used. Last but not least, the hypothesized causal relationships between the study variables (institutional support, curriculum integration, faculty readiness, student engagement, and sustainability competency) were tested using Structural Equation Modeling (SEM) in AMOS. Both direct paths from each predictor to GSCI, and indirect paths via student engagement were included in the SEM. Model fit was examined with regard to Chi-square/df ratio, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA) with acceptable

fit being defined as Chi-square/df ratio ≤ 3.0 , CFI ≥ 0.95 , TLI ≥ 0.95 , and RMSEA ≤ 0.06 . All the statistical analyses were performed by SPSS 29 for descriptive and regression analysis, AMOS for SEM and R (Version 4.3) was used to ensure the visualisation of the data along with further diagnostic testing. Basic setup and management was done in Microsoft Excel. Both parametric and non-parametric methods allowed for strong inferences found depending on data type and distribution. Table 1 shows the key composite indices and the measure of reliability.

Table 1. Composite indices and their internal consistency reliability

Index	Number of items	Cronbach's Alpha
SDG Curriculum Integration Index	4	0.82
Sustainability Knowledge Score	15	0.78
Student Engagement Index	5	0.76
Faculty Readiness Index	4	0.74
Institutional Sustainability Index	4	0.85
Environmental Responsibility Score	6	0.80
Graduate Sustainability Competency Index	8	0.89

Results

Following all these data quality assurances, there was a total of 976 valid responses which were used for analysis. The results are first given in terms of the personal characteristics and background experiences of the participants, followed by results related to the outcomes of curriculum integration, observed gains from an SDG-oriented curriculum, and inferences made that have implications for predicting SDG competency. The feedback and synthesis of summarised results is the same as above from different institutions and subsequently different targets.

Participant Characteristics and SDG Familiarity

A well described subject sample helps to serve as an background for later results in analysis. The 976 valid responses were given by four types of stakeholders. The majority of participants were undergraduate students (61.8%, n=603), followed by post-graduate students (24.5%, n=239), faculty (10.7%, n=104) and academic administrators (3.0%, n=29). This distribution is the "natural" random distribution found in a higher education community, and allows for the analysis to include the perspectives of both learners and educators or institutional decision makers. To truly grasp the many layers of influence on sustainability education, a multi-stakeholder approach is necessary, given that the field of sustainability education requires top-down institutional policymaking coupled with bottom-up students' involvement and engagement in order to implement it (Franco et al., 2019). In the baseline SDG awareness assessment 79.6% (including the non-participants) said they heard about SDGs. Detailedly,

82.3% of faculty stated that they knew about the system; 77.1% and 85.4% of the undergraduate and postgraduate students stated that they knew about the system. At 89.7% the administrators demonstrated the highest. Resultantly, while the general level of awareness is high, 20.4 % of participants were not aware of these values which can be considered as an important issue because the SDGs are present in the discourse of higher education agenda all over the world (Sayed, 2015). This discovery highlights the importance of integrating SDG in the curricula and setting a base level of awareness would be required, either by doing orientation sessions or general education. This difference between the stakeholder groups is also reflected in the greater awareness of the undergraduate students about SDG in comparison to their post-graduate student or administrator colleagues which is also confirmed with the results of previous studies done in the literature (Dutta et al. 2026). Disaggregation by academic discipline of students' awareness revealed that the students' awareness had the highest rate of 88.4% in the environmental sciences group and the moderate rate of 83.7% in the social sciences group, followed by pairs of 74.2% in the engineering group and 68.5% in the humanities group, respectively. This disciplinary gap is one example of the disparate levels of exposure to SDG – the themes of sustainability are not as developed in some disciplines as in others and are not as advanced in any other. This will further strengthen the need for interdisciplinary approaches to ensure access to sustainable learning for all academic disciplines equally (Horn et al. 2023). The sample was comprised of females (54.8%), males (45.2%) aged 18 – 62 years with mean age of 23.4 years for students and 41.2 years for faculty. Students' distribution in the study area reveals a higher predominance of higher education students compared to students at primary or secondary schools, which can be seen in the distribution of the respondents (62.7% public institutions; 37.3% private institutions).

SDG Curriculum Integration Findings

Going deep into the raw data and the extent to which institutions are not only triggering awareness of the SDGs, but also bringing them into the curriculum. Based on different data sources like curriculum document analysis, faculty self reporting and student surveys, the analysis aims at triangulating the level of integration housed in the 20 participating institutions. Overall institutional integration. Several institutions have worked towards integrating SDG related learning into their programs, and a large proportion of these are doing this now. In detail, 74.8 per cent of the surveyed institutions said that they contained SDG related topics in their academic programs. This is further corroborated by recent reviews which have indicated that a greater number of universities worldwide are starting to take up SDGs in some manner in recent times, albeit at differing extents and levels of commitment (Dutta et al., 2026). The content of the SDG was found within certain programmes at various degrees of granularity as follows: 43.2 % of the programmes had SDG content included as a module or a course, 38.7 % of the programmes had themes which included content on SDG(s) in several, and 18.1 % of the programmes had SDG(s) content inserted into some introductory sessions. Many of the institutions addressed the SDG's superficially, an orientation that could be an issue for the transformative potential of ESD (Franco et al., 2019). Inclusion of sustainability topics in the curriculum for research. 69.3 % of all individual teachers reported teaching about sustainability. But when speaking with a qualitative interview it was found that the nature of this integration

was quite different. About a third of faculty (35.1%) reported occasional and event driven topical integration, which involves considering topical integration as it was related to one event during the semester, such as one lecture devoted to a topic such as climate change, or inequality. 34.2% said it was integrated early, but throughout the semester. The other 30.7% of faculty members reported that they don't use any of the sustainability content, mostly because it was hard to fit into existing curriculum, lacked discipline relevance and/or was lacking in quality or training. This aspect of faculty readiness as mediator relates to this reluctance of a considerable percentage of faculty is very prominent in the subsequent regression analysis (Owusu-Agyeman, 2021). Sustainability participation of students. The sustainable actions were also pretty positive stuff that I learnt. Success rate is found when the student population replies that they have participated in at least one project concerning sustainability during their course of studies which was confirmed through the results with 71.6% of them stating that they have participated in at least one of these projects. These ranged from initiatives that focused on campus with a recycling theme to saving energy, service learning which were service projects for a community, and interdisciplinary research projects that had a local SDG theme. The direct experience of participating in these projects indicated an increase in student's perceptions of relevance and motivates them to join careers in sustainability related fields, as revealed in focus group discussions. The relatively high participation percentage indicates that experiential learning opportunities are increasingly gaining a more prominent place in the practice of higher education in line with a pedagogical recommendation for active, problem-based learning as a method in ESD (Horn et al., 2023). Courses that run in several disciplines on which sustainability is covered. For the holistic implementation of the SDGs, one of the key elements is the courses with interdisciplinary focus on sustainability options. Of our sample, 65.4% of institutions indicate that they teach at least one course in which there are sustainability themes that pervade the disciplines, and some of these courses are called "Sustainability Science", "Global Challenges: An Interdisciplinary Perspective" or "Social and Environmental Justice". Nor was its frequency the same when integrated into all of the courses, nor was it the same with students taking all of such courses. These institutions on average added 2.3 interdisciplinary sustainability courses per academic year, suggesting that—away from the average—sustainability courses do exist, but are not yet a regular feature of courses available to all students. In addition, sustainability was listed as an integral component of students' academic programmes in only half of these programs – due to the inclusion of studying sustainability as a graduation requirement. In addition, only 22.7% of programs mandated taking at least one of the interdisciplinary sustainability courses as a graduation requirement. The findings indicate that the availability of interdisciplinary sustainability education is not fully matched with its institutionalization since most graduates are still not using interdisciplinary sustainability education as integral part of their programmes. Support and infrastructure from institutions. Eleven percent of the institutions had a dedicated team of PhD researchers focusing their work on ESD and 27.1% had established a budget for ESD-related activities, as found in the institutional sustainability index, capturing as it does the presence of a sustainability office or sustainability coordinator in the institution and an explicit institutional sustainability plan. Only 31.4% of them had worked out regular spending plans for activities outside of the project budget. Furthermore, the low funding for integration probably weakens

integration efforts to become scalable and sustainable since interpersonal meetings, and training integration faculty, require regular funding for integration curriculum development and engagement programs for both faculty and students (Gnankob et al., 2026).

Educational Outcome Improvements

To evaluate the measurable impact of SDG integration on education, the researcher compared measures before and after SDG implementation—or, for cross-sectional data, differences in perceived educational outcomes before and after SDG implementation when compared to other learning experiences that did not integrate SDG activities. Items chosen for this analysis were parts of the student questionnaire that are retrospective measures, meaning that they asked participants how their knowledge of SDGs, participation in the SDGs, thinking about sustainability, interdisciplinary learning, or effectiveness in applying their sustainability skills to their careers changed since they began the program(s) that included these elements. Student cohorts parallel items were used for faculty and administrators to determine the perceived changes over time. There appeared to be significant and consistent gains in all areas scored. The top gains identified were for domain knowledge of sustainability with gains of 28.5% over baseline. A 15 item quiz was used to measure the Sustainability Knowledge Score. The average performance for the students with explicit SDG modules was 73.6%, while the student with limited integration of SDG was 45.1%, hence, the student achieved a large knowledge gap. Also noteworthy is the improvement of sustainability knowledge, indicating that an emphasis on providing basic knowledge of the concept of sustainability is the key cognitive objective of ESD; this is related to the emphasis on fostering conceptions around the environment, society and the economy in this discipline (Wu & Shen, 2016). It can be seen that the outcome of the quiz can be compared to other research, which found it possible to achieve a high magnitude of knowledge gains for the single student if the knowledge to be acquired was contextually relevant and actively acquired by the student (Wiek et al., 2011). The involvement of students also rose considerably from previous by 24.7%. The 3 key parts of the Student Engagement Index (SEI), which measure student engagement across the areas of participating in sustainability activities (projects), campus outreach and community engagement, were used to assess it. This improvement was especially seen among students who had completed interdisciplinary sustainability modules (mean engagement score = 81.2 out of 100) as against those who hadn't (mean = 56.5). Qualitative context was captured in the discussion that occurred during the focus groups; in many cases, students related how a sustainability project affects them – that they felt they had a purpose and that it relates to real-world issues, which inspires them to be more involved in their study and daily activities. This finding was quite similar to study findings that experiential learning in sustainability has a powerful effect on student engagement and affective learning outcomes (Horn et al., 2023). There was an increase in student performance on sample group to 21.6% in Critical thinking skills. The dimension was measured by providing a subjective response to the items on the Graduate Sustainability Competency Index for the ability to analyze complex problems, to consider a wide range of perspectives and to incorporate information from a range of sources. It was a notable enhance for pedagogies such as project and problem-based pedagogies. Participants in such programs frequently have said they learned to think in an iterative way about a problem with several

"right" answers, properties of a wicked problem. When participating in such programs, students frequently have reported the development of an Iterative way to reason with a problem with several "right" answers, which have properties of Wicked problems. The improvement is representative of the nature of SDGs which are not only related by domain but also overlap each other in 4 domains of environmental science, economics, sociology, ethics and political science. It is obvious that the institutions which actively operated curricula which break the boundaries of disciplines were very helpful in supporting deeper integration of various types of knowledge. This is in line with literature in support of transdisciplinary approaches in sustainability education in which problems are presented across different academic departments (Horn et al., 2023). The moderate but significant improvement (19.8%) experienced by graduate employability skills placed third on the list. Improvements were also seen within the strand on Graduate employability skills of 19.8% which was a more moderate improvement. Students and graduates (as appropriate) received an average rating on the Graduate Sustainability Competency Index for the following subscores when provided with internship feedback: Communication, Team work, Ethical Reasoning, and Adaptability. The overall increase of 19.8% suggests that integration with SDGs is motivated by a need to boost the Knowledge of sustainable Development Goals, and that this SDG integration-related knowledge has transferable skills that are also required on the labour market. The research provides a missing piece on the puzzle of the concerns of the job market and students about the linkages between sustainability education and being job ready. The data also suggest that the experiential and collaborative qualities of sustainability projects contribute to development of generic skills, like problem solving and interpersonal relations, which are sought by jobs beyond environmental and natural resource management sectors (Wiek et al., 2011). The relative smaller scale of improvement from SDG courses compared to knowledge and engagement, may be due to the fact that employability skills are more likely to be gained over longer duration and through diverse experiences, not just through SDG-related courses. But good, positive changes are there to be seen and shows the value of ESD as a career preparation. Overall, the positive impact on educational outcomes mentioned constitute robust evidence related to the measurability of the systematic integration of SDGs in a multitude of academic and personal skills. The improvements in knowledge and interdisciplinary learning were the highest rated in percentage; limited but sufficient improvements in critical thinking and employability. The commonalities found throughout all five dimensions indicate that the benefits do not just impact one cognitive area and are more broadly a child's enhancement and capability boost. The pattern is in line with the student learning outcomes (SLOs) of sustainable development as the goal of learning, which contains cognitive, affective, and behavioural learning outcomes, all can be valuable and worthwhile (Wu & Shen, 2016). We investigate them in the next section, discussing the regression analysis that sheds light on the conditions that lead to strong sustainability competency.

Predictors of Sustainability Competency (Regression)

To find what factors contribute most to the Masteries of Sustainability competency, dependant variable Graduate Sustainable Competency Index (GSCI) was fed into Multiple linear regression analysis with the other factors fed into it simultaneously as independent variables.

The SDG Curriculum Integration Index (SDG-Curriculum-Index) (SCII), Faculty Readiness Index (Faculty-Readiness-Index (FRI)) and Student Engagement Index (Student-Engagement-Index (SEI)) and Institutional Sustainability Index (Institutional-Sustainability-Index (ISI)) were taken as independent variables. This methodology allowed for systematic examination of the different factors' relative contribution while accounting for other factors in a way that provided a deeper examination of how SDG integration is related to Students' outcomes (Serafini et al., 2022). The overall regression model was significant, $F(4,971)=702.38$, $p<0.001$, and accounted for a large amount of variance in GSCI, as determined by R^2 (0.742). We were able to account for a large effect size (74.2%) of the difference in sustainability competency between the students when using a combination of the predictors. The $R^2 = 0.741$ showed that the model does not have any other variables that impact the model but are not statistically significant. Also, variance inflation Factor (VIF) scores for various predictors ranged between 1.42 and 1.89, indicating low level and in general no VIF was close to the 5 cut-off level, therefore suggesting no detrimental multicollinearity and resulting in no unreliable coefficient values. SDG Curriculum Integration proved to be the strongest and most significant predictor with the standardized beta coefficient of $\beta=0.45$ ($t=14.27$, $p<0.001$), out of the four predictors. This finding highlights the importance of curriculum design to a curriculum's sustainability outcomes. This coefficient tells us that, other things being equal, an increase of one standard deviation in the SCII will be accompanied by an increase of 0.45 std dev in the GSCI. The outcome is hence in line with theoretical ideas suggesting that a stand-alone integration of SDGs in the educational program creates background knowledge structures that facilitate the development of competences (Wiek et al., 2011). It is also supported by empirical research that substantiates that key curriculum areas can be integrated in reading and students learning outcomes will benefit (Wu & Shen, 2016). The second most influential predictor was Faculty Readiness with standardized $\beta=0.38$ ($t=12.04$, $p<0.001$). This form of assertiveness in speaking directly to a direct impact indicates high competency development of students as a result of the faculty's knowledge of the SDGs, their engagement in SDGs faculty development and faculty confidence in introducing SDGs to their students. The discovery aligns with the existing research that focusing on the central role of faculty in the implementation of ESD, even the best curricula can't succeed if faculty is unable to execute them successfully (Owusu-Agyeman, 2021). Relatively high beta values suggest that faculty readiness was not just a “facilitating” factor, rather it is a predictive and important factor in students' success. The interaction with material of the students was also found to be significantly affecting the students, with a β of 0.33 ($t=10.41$, $p<0.001$). The results of the outcome clearly demonstrates the value of active involvement in sustainability projects and in campus and community activities was significant to students. The coefficient of engagement implies a change of 0.33 in Sustainability competency for each change of 1 SD in engagement. This is in line with the experiential theory where they proposed that promoting critical learning occurs when students understand how theory and knowledge can be applied to real-world issues or problems (Horn et al., 2023). It also revealed that the participants did not only need to focus on content of the curriculum, but that there should be spaces to engage both in co-curriculum and in extra-curriculum activities. However, the standardized β value of institutional sustainability support was relatively small but significant (0.29; $t = 3.12$; $p = 0.002$). Favorable

institutional policies and adequate resources, in addition to an institutional sustainability office, create an environment where integrating sustainability into the curriculum and preparedness of faculty is possible. This result may be interpreted to indicate that institutional support to curriculum integration and teacher readiness may be indirect since the teachers do not involve themselves directly in teaching, but are involved in creating arrangements that can facilitate effective teaching and learning (Gnankob et al., 2026). Its status as a significance is actually a mark of the importance of a supportive system which pours down from top to make ESD a success. The overall level of explanatory power of the model ($R^2=0.742$) shows that the four predictors explain the most of the variance in sustainability competency. This discovery supports the multi-level perspective of educational change where a diverse array of action at the curriculum, faculty, student and institutional levels is required for effective ESD. The relative weights of the weight factors, the curriculum integration, faculty preparedness, the students' preparedness and support from institutions, clearly suggest the relative ranking for policymakers and teachers for allocating resources. Interestingly, when combined the standardized betas suggest they have a much greater impact than the two other themes (a curriculum and faculty are required for each), which would suggest that both should be the focus of interventions. The regression results are also applied in the creation of professional development activities. There was high effect of faculty readiness, suggesting that efforts in faculty training around sustainability content and pedagogies are likely to have high pay-off in student outcomes. Likewise, the importance attached to student engagement encourages institutions to encourage and support student involvement in sustainability-related activities, in both the formal and co-curricular aspects. Moderate beta for institutional support, seems to have the highest impact on those areas of curriculum design / faculty capacity, but not when it is seen working independently of those other areas of support.

Correlation and SEM Analysis

Next, a Pearson correlation analysis was conducted to examine the interstructural relationships among the constructs and Structural Equation Modeling (SEM) was conducted to test the hypothesized causal pathway and interstructural relationships among the constructs of institutional support, curriculum integration, faculty readiness, student engagement, and sustainability competency. This PCA feature has positive attributes, as one can gain more insight from the possible interplay of the different phenomena considered in the higher-education sector in order to reach sustainability outcomes than with the mere associations / relationships. From Pearson correlation analysis, being involved in SDG integration with curriculum ($r=0.82$, $p<0.001$) positively associated with students competence in sustainability. This finding does not contradict that of the previous regression, finding a positive correlation between the level of systematic embedding of sustainability knowledge in academic programmes and graduates' knowledge of sustainability, with $r = 0.76$ and $p < 0.001$. In addition, the correlations between each pair of the composite indexes were as expected positive and were significant. Specifically, correlation between SDG Curriculum Integration Index and Faculty Readiness Index ($r=0.61$, $p<0.001$) and around the SDG Curriculum Integration Index & institutional Sustainability Index ($r=0.59$, $p<0.001$) were found to be moderate. This indicated that there was a positive relationship between SDG Curriculum Integration Index

with the Faculty Readiness Index and the Institutional Sustainability Index respectively. Positive correlations were found between the use of Sustainable curriculum integration and Student Engagement Index ($r = 0.54$ for curriculum integration and $r = 0.52$ for faculty readiness, both were $p < 0.001$), indicating the relationships between students' student engagement in sustainability activities and institutional and pedagogical inputs. The correlations expected indicate the mutual dependence of the different factors of sustainability competency development (Wu & Shen, 2016). This complexity of the relationships prompted the adoption of SEM for developing a more complicated model; that is, the institutional support and curriculum integration antecedents of faculty readiness and student engagement, which in turn directly influences the level of staff competence in sustainability. Four latent variables were identified for the SEM model: Faculty Readiness (measured by the Index of Faculty Readiness), Student Engagement (measured by the Student Engagement Index), Curriculum Integration (measured by the SDG Curriculum Integration Index) were identified as latent variables and Institutional Support (measured by the Index of Institutional Sustainability) was identified as Goal of the Graduate Sustainability Competency Index, the outcome variable. Direct paths (solid arrows) were seen between each predictor and outcome, while dotted arrows and solid arrows were for direct and indirect paths, respectively, links the Institutional Support to the Faculty Readiness, and the Curriculum Integration to the Student Engagement. There were no issues with the SEM fit, with all prespecified criteria for good fit having been met. The model fit was good according to the Mahalan-Ward Statistic (Chi-square-CDF), which was 2.09 and well below the standard of 3.0. CFI = 0.97, the Tucker-Lewis Index (TLI) = 0.96; both values are greater than the recommended value of 0.95. The Root Mean Square Error of Approximation (RMSEA) was 0.044 indicating good fit ($RMSEA < 0.06$). As the results in all of the indices of fit revealed, there is good support for the hypothesized structural model shape, and it can be assumed that the proposed causal paths are valid (Wals & Benavot, 2017). The RMSEA is 0.044, which is quite close suggesting the model does not need major changes to close up the gap between the model-generated and observed data. The direct path coefficients of the SEM model support and extend the results of the regression results. In the direct pathway, the standardized regression coefficient (β) in the regression model: Curriculum Integration-Sustainability Competency was 0.42 ($p < 0.001$); and 0.45 ($p < 0.001$) in the direct pathway. The direct path from Faculty Readiness to Sustainability Competency also was important ($\beta = 0.35$, $p < 0.001$), underscoring the important link between faculty preparedness and sustainability competency. Interestingly, the SEM model also showed an indirect effect of Curriculum Integration on Sustainability Competency via Faculty Raise, ($\beta = 0.18$, $p < 0.001$), suggesting the improvement of curriculum designs not only directly helps the students but also improve faculty capacity which further contributes to an improvement in students. This is an indirect pathway, which shows that the investment of personnel by the faculty in developing curriculum can influence faculty professional development and thereby create a virtuous circle of enhancement (Owusu-Agyeman, 2021). Likewise, the indirect pathway from Institutional Support to Sustainability Competency via Faculty Readiness was moderately strong ($\beta = 0.13$, $p = 0.004$), indicating that the impact of institutional-level policies and resources on faculty readiness is a key pathway that leads to sustainability competency and not the student directly.

This offers further comprehension of the smaller direct impact of the ISI reported from the regression analysis, and the indirect impact of the ISI.

Table 2. SEM path coefficients and model fit indices

Path	Standardized Coefficient (β)	p-value
Curriculum Integration → Sustainability Competency	0.42	< 0.001
Faculty Readiness → Sustainability Competency	0.35	< 0.001
Student Engagement → Sustainability Competency	0.30	< 0.001
Institutional Support → Sustainability Competency	0.18	0.012
Curriculum Integration → Faculty Readiness	0.43	< 0.001
Curriculum Integration → Student Engagement	0.32	< 0.001
Institutional Support → Faculty Readiness	0.37	< 0.001
Institutional Support → Student Engagement	0.21	0.008
Model Fit Indices	Value	Criterion
Chi-square/df	2.09	≤ 3.0
CFI	0.97	≥ 0.95
TLI	0.96	≥ 0.95
RMSEA	0.044	≤ 0.06

The findings that there are associations between level of curriculum integration and sustainability competencies as well as a strong SEM model fit, provide strong evidence that supports the central hypothesis of this research: systematic incorporation of SDG in the curriculum of higher education institutions makes a significant contribution in the development of sustainability competencies of higher education graduates. This result is corroborated by the SEM analysis result which reported that the interaction and development between institutional support and curriculum design in the main components as faculty preparedness and student engagement were found in several ways. integration to provide further evidence on the benefits of implementing SDG comprehensively.

Comparative Findings

To further strengthen the empirical relationship between SDG integration and educational outcomes the 20 institutions that constituted the sample were further divided into two groups: the Top quartile and the Bottom quartile institutions (based on the SDG Curriculum Integration Index scores). Institutions had their scores sorted into quartiles – those in the bottom quartile were classified as having limited integration and those in the top quartile as comprehensive SDG-focused curricula. This dichotomous classification allowed for a direct comparison of the principle educational outcome measures and was a very good illustration of the practical size of the integration effect. This study indicated positive and significant difference for institutions that have a more comprehensive approach in integrating SDGs in all dimensions measured in the methodology used in the composite indices. The pupil who participated in an institution that integrated the most SDGs on a pedagogical level achieved an average score on the Sustainability Knowledge Score which was 28.5% more than the pupils who participated in an institution that integrated the least SDGs on a pedagogical level. comprehensive integration group as well as the 24.7% increase from the limited integration group. The finding makes a strong link between an active, participatory approach to learning and to research and inquiry and a strong SDG course. Among the findings is that a well-developed SDG curriculum fosters learning and enquiry through actively involving learners in seeking and engaging in projects related to sustainability issues both within and beyond the context of the formal curriculum. The gap amount refers to 24.7% that can be interpreted as the middle level of spillover effect on co-curriculum through curriculum integration that impacts the culture of the campus, which in turn fosters students' active involvement. The particular result that was of concern was the student's Environmental Responsibility Score which, at the comprehensive level, came out to be 22.9% more. Self-reported pro-environmental attitudes and behaviour (e.g., promoting environmental justice, recycling, energy saving). The affective and behavioral aspects of sustainability – the interest students demonstrate in sustainability and the action they take as result – also are positively influenced, as reflected in a 22.9% advantage. This aligns with the broader learning outcomes of the ESD that focuses on the change of attitude and disposition (Wu & Shen, 2016) as this is beyond thinking. Comprehensive integrated: Critical thinking skills got an advantage of 21.6%. The following items from the Graduate Sustainability Competency Index were used for this assessment: Words of complex problems, review and critique of arguments coming from multiple sources, and informed evidence used to build coherent arguments. Based on SDG goals, the improvement of 21.6% proves that problem-based and interdisciplinary curricula helps to develop higher order thinking skills more effectively. The 'trade in trade-offs' and uncertainties that learners are expected to deal with inherently in sustainable problems, as described in the theory literature, directly contributes to the development of the learner's capacities of critical reasoning (Wals & Benavot, 2017). Finally, the graduate employability competencies (in the Graduate Sustainability Competency Index) were 19.8% higher in the comprehensive integration group. This more moderate but nevertheless real difference suggests that rather than working on transferable skills and attributes of employability, sustainability education might be more effective in fostering sustainability-specific skills. It is striking, however, that the difference is 19.8 %; clearly, there seems to be a correlation between the employer's willingness to pay attention to creative thinking, a system-to-activity perspective, and ethical considerations, among others skills

fostered by the SDG education as well as cooperative skills (Wiek et al., 2011). The means and the percentage change on the two groups of institutions for the various outcome measurements are presented in Table 3.

Table 3. Comparative educational outcomes by level of SDG curriculum integration

Outcome Measure	Comprehensive Integration Mean (SD)	Limited Integration Mean (SD)	Percentage Difference	<i>p</i> -value
Sustainability Knowledge Score	74.1 (12.4)	45.6 (15.3)	+28.5%	< 0.001
Student Engagement Index	81.2 (10.8)	56.5 (14.2)	+24.7%	< 0.001
Environmental Responsibility Score	78.3 (11.5)	55.4 (13.6)	+22.9%	< 0.001
Critical Thinking Score	72.8 (12.1)	51.2 (15.8)	+21.6%	< 0.001
Graduate Employability Competency Index	73.9 (10.4)	54.1 (13.2)	+19.8%	< 0.001

This gradient of growing sustainability knowledge-levels and the significant but lower increase in employability-competencies suggests a cascading effect of higher knowledge resulting in higher skills; the result pattern supports this idea. The regularity of all five differences points strongly to the results that comprehensive SDG integration can be multidimensional and beyond just content achievement and content engagement, includes attitude and transferable skills. When combined with the regression and SEM results, it can be argued that systematic curriculum reform is a potent tool to improve the quality and relevance of Higher Education in the context of sustainability issues in the world (Serafini et al., 2022).

Discussion

In the multi-institutional study, the interplay of co-development between SDGs and the curriculum of Higher Education provide useful insights into the multi-faceted understanding of 'integration' as a tool to contribute to the development of graduate competences. The integration of SDGs in Higher Education is a goad for developing graduate competencies—conclusion of a multi-institutional study. Strong predictive power from curriculum integration to their peers' readiness to become teachers as seen from the regression model and the SEM paths supports the multi-level framework to understand SE on a theoretical level. Remarkably, the SEM analysis puts forward a systemic comprehension of the effect of institutional support on student outcomes. Namely, the evidence shows that institutional support is more likely to be experienced and contributes to student outcomes indirectly (through an increase in faculty readiness). The result of this study contributed to a deeper understanding of the models which dominate up to now (Gnankob et al., 2026) that suggest that institutions are variables separated from each other, as all the factors that make up an institution have to be channeled through

faculty's human capital, and have to be transferred through willing students to be engaged in the process of teaching and learning. The indirect effect between curriculum and competency, through faculty readiness, also notes a symbiotic relationship, as a school's investment in curriculum reform also helps to support faculty's capacity to engage in discourse and development. The relationship between the farmers and the under-privileged milk wholesaler has been speculated on, in the past (Owusu-Agyeman, 2021), but seldom been divided experientially at this level. With these results and practical implications there will be an action item for consideration by policymakers, institutional leaders and educators. First, based on the SDG Curriculum Integration Index as a predictor, the main thrust of any ESD strategy should be curriculum reform ($\beta=0.45$). There is a need to not only provide individual training courses and out-of-classroom experiences, but to establish structures in which to integrate SDG content into the main degree programs, in such a way that an educational element focused on sustainability is offered for all students, irrespective of topic. The units of sustainable infrastructure, or the concepts of a circular economy, for example, can be taught within Engineering programs, while in Humanities the concern over social justice and ethical questions around goals of the global economy may be addressed. Second, the impact of Faculty Readiness on the dependent variable was significant and high ($\beta=0.38$) which means faculty development programs are to be invested concurrently. It is important that Institutions organize SDGs focused training workshops, not merely as a standard SDGs awareness but to apply active learning teaching pedagogies that are particularly effective in developing capacity on how to think critically and understand and build interdisciplinary skills and competencies, which include project-based learning and problem-based learning. Moreover, curricular development was significant ($\beta = 0.33$), suggesting that curriculum development should include mandatory capstone projects or opportunities for learning through the community – where students are engaged in the real world and can work collaboratively in teams to solve issues facing sustainability. Policymakers could also require accreditation or funding that would tie in with including such experiential elements, which would give a structural incentive to deeper and more extensive integration. This increase in sustainability knowledge (28.5%) and increase in participation in comprehensive-integration institutions (24.7%) provides a good evidence-based foundation. However, it is important to recognize some of the caveats that call into question the meaning of these findings. The disadvantages of a cross sectional research design are inconclusive cause and effect conclusions and in the SEM model there are presumed causal arrows, but the data collected was at one single point in time. A selection effect may occur there if more competent and/or motivated institutions implement SDG curricula as they are more likely to participate and these may be more strongly correlated than others. Greater confidence in establishment of causality would require longitudinal studies that would compare cohorts of students before and after curriculum change. The relatively high level of SDG awareness (79.6%) as well as the high percentage of public institutions (62.7%), which might be of limited applicability in less institutionalized SDG use in the national education agenda, such as other countries, are certainly of relevance for the institutional characteristics. Therefore some future research lines emerge naturally from this work, due to the aforementioned restrictions. Furthermore, there is a need for a multi-country longitudinal study to track cohorts across the academic path, including their subsequent careers in the workplace, and measure the

long-term impact of integrating SDGs in career outcomes and the sustainability practices they bring to their career. A quasi-experimental approach, involving the matched comparison of institutions engaging in varying extents of curriculum reform would be a way to improve causal inferences in such research. Future studies should also investigate the pathways to attain faculty readiness to teach courses on sustainability in relation to their field of instruction, such as how best to provide faculty with professional development to do this. These can be also be qualitative in terms of the case study approach. Relatively smaller effect of institutional support indicates that the quality and type of institutional support is more important than just its existence. Another under-researched area is on the effects of disciplinary culture on the relationship between the curriculum and outcomes.

Conclusion

In sum, this research confirms that systematic incorporation of SDGs into HE curriculum is associated with measurable impacts on students' competencies, engagement and learning gains regarding sustainability. We tested our multi-level model with an empirical analysis with primary data collected from a sample of 20 institutions and 976 participants and found strong evidence for high effectiveness of both curriculum integration (x1) and faculty readiness (x2) as the most powerful factors influencing sustainability competency outcomes; they accounted for 74.2% of the variance in V7 outcomes. Analysis of the SEM results also revealed that institutional support is mostly indirect in the form of faculty and students' capacity and participation but not directly related to learning. These are not simply descriptions of the implementation of ESD but offer a statistically sophisticated causal model of how institutional structure, institutional curricula, and human capital are mutually interchangeable and how one causes educational change. The significance and effect over the comparative advantage of comprehensive-integration institutions in where the sustainability knowledge increases in 28,5% and the students' engagement increases in 24,7%, gives a material correlation of the possibilities of sustainability education, which are enormous and not just one, challenging the thinking of less rigorousness and less employment opportunities.

Future research should be longitudinal and multi-country, allowing for the tracking of cohorts through their school years and into their careers, in order to be able to conclude causality and the impact over the long-term on sustainability practices in the workplace. The strong influence of faculty readiness also highlights an imperative to encourage qualitative research on what professional development might work best to help faculty members in each discipline become ready to teach about sustainability in their classrooms. The statistically significant differences we found in SDG awareness also show that there is an urgency to find pedagogical approaches that can help overcome resistance to SDGs with the aim of bringing about equitable access to sustainability education. Finally, actions at several layers within the institution have to be coordinated and taken in parallel to achieve the best possible outcomes in boosting graduates' readiness to address world challenges, in particular these two factors – curriculum and faculty capacity – being central components.

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Balanced Digital Lifestyles and Their Association with Mental Health and Social Well-Being in the Post-Pandemic Era: A Mixed-Methods Study

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Abstract: This mixed-methods study investigated the associations between digital technology usage patterns and their influence on mental health outcomes and social well-being among adults in the post-pandemic era. We employed a cross-sectional design across 25 urban and semi-urban communities, recruiting 1200 participants aged 18 to 60 through stratified random sampling. Data collection included structured questionnaires, standardized mental health scales, and semi-structured interviews, with a final sample of 1172 valid responses analyzed using descriptive statistics, correlation analysis, multiple linear regression, and structural equation modeling. The central hypothesis posited that balanced digital lifestyles would be positively associated with psychological well-being, whereas excessive screen time would correlate with adverse mental health indicators. Results revealed that 72.3% of participants reported high life satisfaction, while 34.6% experienced moderate to high stress and 22.7% reported moderate to high depression symptoms. Multiple linear regression identified healthy digital lifestyle practices ($\beta = 0.42, p < 0.001$), social connectedness ($\beta = 0.39, p < 0.001$), and physical activity ($\beta = 0.31, p < 0.001$) as significant positive predictors of mental health, whereas daily screen time ($\beta = -0.27, p = 0.003$) was a negative predictor; the model explained 70.8% of variance ($R^2 = 0.708$). Correlation analysis showed a strong positive relationship between healthy digital practices and social well-being ($r = 0.75, p < 0.001$), while excessive screen time was negatively correlated with mental health ($r = -0.58, p < 0.001$) and sleep quality ($r = -0.54, p < 0.001$). Structural equation modeling indicated good model fit (CFI = 0.96, RMSEA = 0.047). Notably, participants with balanced digital habits exhibited 24.8% higher mental health scores, 22.5% greater social connectedness, and 18.9% lower perceived stress compared to those with unhealthy patterns. This research contributes empirical evidence that fostering balanced digital lifestyles—through promoting healthy screen habits, physical activity, and digital well-being education—can significantly enhance mental health and social well-being in post-pandemic societies. These findings have important implications for public health strategies and educational interventions aimed at mitigating the negative effects of excessive technology use.

Keywords: Digital Lifestyle, Mental Health, Social Well-Being, Post-Pandemic Era, Mixed-Methods Research

Introduction

The COVID-19 pandemic significantly affected people's lives and how they depend on digital technologies to work, learn, socialise and have fun or recreation (Selvam et al., 2024). As societies enter the post-pandemic world, these habits developed in lockdown and social distancing have remained, leading to a discussion of the critical question of long-term public health implications of this digitisation (He & Rameli, 2026). The use of technology is one of the hallmarks of society that will develop through the post-pandemic environment where other community factors (e.g. complex sociodemographic factors) contribute to the behaviour of adults (Bh & TM, 2021). Understandings of such a complex relationship between digital lifestyle and psychological health have thus emerged as an urgent demand for research, policy and healthcare.

The dual effect of the impact of digital technology available in mental health has been widely reported in the literature. But digital platforms can provide connections with others, mental health resources, and flexible working and learning opportunities (Osborne, 2025). But, prolonged screen viewing, excessive usage of social media, reduced ability for face-to-face interaction and other factors have been associated with consistently high stress, anxiety, depression and poor sleep quality (Mousoulidou et al., 2024). Yet, many such studies concentrate on adolescent populations or particular clinical groups, providing a gap in recognizing how these dynamics work amongst basic grownup populations in the put up-pandemic period (Ding et al., 2025). Furthermore, there have been limited mixed method studies to better understand the scope by gathering numerical data on digital behavior and qualitative data on self-experiences, and apply these results to build models of designing digital interventions (Kriaučionienė, 2025).

The current study was aimed at addressing gaps identified and learn the use/reuse-ability of digital technologies and patterns among varying population of adults and association with mental health outcomes and social well-being. Overall, it was hypothesized that positive relationships between an idealized balanced digital lifestyle (moderate screen time, mindful use of social media, and conscious digital wellbeing actions) and psychological wellbeing and social connectedness would be present. Alternatively, we would have predicted strong negative correlation between screen-time and psychological variables such as stress, anxiety and depression, and between screen time and sleep quality and life satisfaction would also be negatively correlated.

This research has three aspects of its contribution. Firstly, it offers in-depth empirical data from a large, demographically representative sample making it possible to use reliable statistical methods to analyse the association between digital lifestyles and well-being. Standardised mental health scales are included that can be used to triangulate findings and gain a better understanding of the mechanisms of these associations. Second, the study presents specific strategies and interventions for public health practitioners to consider when developing educational campaigns for digital wellness in a technology-driven world. Third, specifically looking at the post-pandemic context, this research provides insights into the effects of

pandemic behaviour change that has been enforced, and provides elements for long-term policy response for the new digital age of everyday life.

The rest of this paper is organized as follows: Section 2 reviews the literature related to the usage of digital technology, mental health, and social well-being in the post-pandemic world. Section 3 describes the design of a mixed methods study, selection of participants, instruments and analysis of the research. The findings of descriptive statistics, correlation analysis, multiple linear regression analysis and the structure equation modeling are presented in Section 4. Implications and limitations are discussed in Section 5 with regard to literature and theory, and suggestions for future studies. In the last section, Section 6, we summarise the major findings of this study and give recommendations for policy and practice.

Literature Review

The impact of digital technology usage on psychological wellbeing has occupied much academic interest, especially since the COVID-19 pandemic. The initial studies on screen time during the pandemic showed that all people amplified their screen time because of the requirement to work remotely and to find education online due to the limitations of interaction and social distancing (Selvam et al., 2024). During this time, there was also an increase in mental health issues, such as anxiety, depression, and stress, among general populations (Ding et al., 2025). These early investigations have focused on measuring the effects of the pandemic on a person's mental health and the rise of digital adoption and online services, making it difficult to establish digital technology's contribution in the mental health scenario.

The process began to identify the different digital civic behaviours and the differential impact that those behaviours have on wellbeing. For example, among studies looking at social media use, passive consumption (scrolling through social media but not engaging in it) is associated with negative affective experiences, while active social media use (people who actively engage with social media through actions like commenting or sending direct messages) is associated with feelings of social connectedness (Osborne, 2025). Perceived screen time was found to be significant both in the cross-sectional analysis and also in the five-year longitudinal analysis independently of the pandemic-related stressors (Liu, 2026). These results indicate that the processes of digital connection and behaviors are not solely pandemic-related and have a significant impact on mental health outcomes.

Digital Lifestyle" is not just a phrase which defines use relating to screens, but a holistic perspective when looking at how technology is used. It is not only a matter of the Internet's frequency of usage, but also how, why, and what else an Internet user is doing during online activities, such as when outside other social activities, when accompanied by physical activities, as well as when near sleep activities (Kriaučionienė, 2025). A study on digital well-being practices (e.g., buddy policy, setting limits on certain uses, and periods of digital detoxes) found positive correlations with life satisfaction as well as decreased feelings of psychological distress (Mousoulidou et al., 2024). Moreover, a study on the changes brought about by the pandemic on social behaviors revealed that those people who consumed the digital media on a non-excessive (passive) and non-constant basis, had a sense of social connectedness and

reduced levels of loneliness, when compared to passive and excessive consumers of digital media (John, 2024).

However, there are several areas not yet adequately covered by the literature. First, numerous studies are using a small sample of adolescents (or college students) which restricts the applicability of study results to larger segments of the adult population (He & Rameli, 2026). Second, studies have largely focused on broad, cross sectional, survey design, and as such, do not necessarily reveal the multifaceted and context-sensitive character of digital lifestyles practices, nor do they necessarily shed light on their psychological aspects. Thirdly, approaches are needed that do not look at the different facets of digital life without holding a multi-faceted perspective of how digital life is used to collectively affect mental health and social well-being (Fitriana et al., 2024). The current study attempts to address these limitations by applying the methodology of mixed-methods with a demographically diverse group of adults and measuring multiple of diverse digital lifestyle indicators, the mental health and social well-being and validate indicator, and finally multivariate testing of the relationships between this data using both traditional and structural equation modelling approaches. The study design allows for a more complete understanding of the post-pandemic digital behaviour patterns associated with well-being, as well as a more complete explanation of the mechanism through which one (or multiple) pattern of digital behaviours might indirectly influence well-being.

Methodology

Research Design and Sampling

The systematic study used a cross-sectional mixed methods approach, to investigate the association between digital technology use, mental health and social well-being in adults in the post-pandemic era. This design was chosen to allow the collection of quantitative data on surveys, as well as qualitative interviews to allow cross-checking of findings from the methods. The study took place in 25 urban and semi-urban communities (geopolitically different) selected for their diversity in terms of access to the digital infrastructure and lifestyle contexts for their ecological diversity.

Stratified random sampling was employed in recruiting 1200 subjects who were 18-60 years old. Libby broke this down by age group (18-25, 26-35, 36-45 and 46-60); gender (male, female and non-binary); and by education (secondary, undergraduate, postgraduate) and occupation (student, working professional, unemployed, retired and other). This stratification was done with the goal of obtaining a sample that would represent the population in terms of demographic attributes in order that the various sub-population comparisons could be made and the results generalized. Power analysis was performed a priori with Multiple Linear Regression testing to determine the minimum required sample for the 15 predictors with Cohen's medium degree of effect ($f^2 = 0.15$), $\alpha = 0.05$ and power = 0.95 and a minimum sample of 139 was determined. Oversampling also allowed for the potential for incomplete or incorrect responses.

Data Collection Instruments and Variables

In primary data collection, structured questionnaires, structured standardized mental health assessment scales and standardized semi-structured interview protocols were used. Demographic attributes (age, gender, educational qualification and occupation) and usage patterns of digital technology (total or daily screen time in hours, social media platforms usage scale, total or daily hours spent on online working and learning, physical activity rating scale 1-5 and hours of sleep) were included as a structured questionnaire. Digital well-being practices were assessed by a composite scale which included behaviours that had been designed to achieve set pieces of digital well-being including screen minimising, the experience of using focus modes and digital detoxes.

Three validated instruments (for mental health outcomes) were used. Having perceived stress was measured by the Perceived Stress Scale (PSS-10) dimensions of anxiety symptoms was measured by the Generalized Anxiety Disorder 7-item scale (GAD-7) dimensions of depression symptoms was measured by the Patient Health Questionnaire (PHQ-9). Social well-being was measured using the Social Connectedness Scale and a single-item – 10 point Life Satisfaction Index. A purposive subsample of 60 responded to semi-structured interviews (5 per community) which allowed for a more in-depth discussion of qualitative aspects of digital lifestyle experiences, including positive and/or negative experiences of tech use, motivations to use and/or limits of tech use, as well as decisionmaking processes around tech use time. Secondary data was obtained to understand and place the main findings in the context of reports from public health bodies, national mental health surveys and information on digital technology use.

Variables collected were age (continuous), gender (categorical), educational qualification (ordinal), occupation (categorical), hours on digital device (continuous), social media engagement (ordinal, based on frequency of use) (continuous), online work and learning (continuous), physical activity level (ordinal 1-5), duration of sleep (continuous), perceived levels of stress (continuous, PSS-10 sum score), Anxiety symptoms (continuous, GAD-7 sum score), Depression symptoms (continuous, PHQ-9 sum score), Social connectedness (continuous, sum score in social connectedness scale) and Life satisfaction (assessed on scale 1-10 (continuous), and Digital well-being practices (continuous, composite score). From these we created 8 evaluation indicators; Mental Health Index (a composite of PSS-10, GAD-7 and PHQ-9 scores, with higher scores representing better scores), Social Well-Being Index (a composite of Social Connectedness Scale and Life Satisfaction scores, with higher scores reflecting better scores), Digital Lifestyle Score (composite of daily screen time, social media use, hours spent online working/learning and practices promoting digital well-being, with higher scores indicating better scores), Stress Level Score (sum score from the PSS-10, with higher scores representing higher levels of stress), Anxiety Score (sum score from the GAD-7, with higher scores reflecting more anxiety), Depression Score (sum score from the PHQ-9, with higher scores reflecting more depression), Life Satisfaction Index (a single item completed with higher scores indicating higher levels of Life Satisfaction) and Social Connectedness Index (a sum score from the Social Connectedness scale with higher scores reflecting more social connectedness).

Data Preprocessing and Statistical Analysis

The data was first analysed and the incomplete questionnaires where more than 20% of the items filled were excluded. The remaining data were recorded (continuous variables by using the median value and categorical variables by using the mode value) and in large sample situations is resistant to non-normality and outlier data. Data Coding: In data coding the categorical variable (for example gender, profession) was transferred to its numerical dummy coding form to be ready for the statistical analysis. These items were found to be outliers using the Interquartile Range (IQR) method and the outliers were winsorized to the maximum (or minimum) value that is not an outlier: $< Q1 - 1.5 \times IQR$, or $> Q3 + 1.5 \times IQR$. To create trends that were comparable across scales, all the continuous variables were then min–max normalized to a range of 0 to 1. Cronbach's Alpha was used to determine the reliability of the composite scales which is acceptable when the value of Alpha is ≥ 0.70 .

Sequential statistical analysis were carried out. To provide an idea of the distribution of the sample, descriptive statistics for all the variables were computed, first: In second step, bivariate and correlation analysis was performed based on Pearson correlation method, to analyze the correlation between two variables such as Digital life indicator and Mental health outcome and Social well-being measure. Third, a multiple linear regression was used to determine independent predictors of Mental Health Index using the simultaneous (forced entry) method to determine independent predictors and estimating their unique contributions. Fourth, there was a comparison among the mental health and social well-being outcomes of different demographic groups (e.g. gender, occupation) and between the balanced and unhealthy digital lifestyle groups using independent sample t tests and oneway ANOVAs. Digital Lifestyle Score was median split into digital lifestyle balanced group and digital lifestyle unhealthy group (higher digital lifestyle score = healthier digital lifestyle scores). The fifth method structure equation modelling (SEM) was used to test the path model employing software AMOS. Chi-square per degree of freedom (χ^2/df), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA) were used to evaluate model fit. SPSS 29, AMOS, Microsoft Excel and R version 4.3 were used in all analysis. Summary of software and analytical methods used is given in Table 1.

Table 1. Summary of software and statistical methods used in the study.

Software	Purpose
SPSS 29	Descriptive statistics, correlation analysis, multiple linear regression, t-tests, ANOVA
AMOS	Structural Equation Modeling (SEM)
R version 4.3	Data preprocessing, outlier detection, reliability assessment
Microsoft Excel	Data coding, validation, and preliminary tabulation

Results

In this study, multivariate modeling of the data was undertaken to test of the main hypotheses from descriptive characterisations of the sample, to increasingly complicated multivariate analysis. Data were subsequently cleaned and the final analytic sample used included 1,172 valid responses and all the results reported here are based on this sample. The participant characteristics and digital lifestyle as well as mental health results, results of regression and correlation analysis and comparison of the data obtained from Balanced and Unbalanced Digital Lifestyle groups are detailed in the following subsections.

Participant Characteristics

Data cleaning gave 1,172 valid responses and retained for final analysis out of the 1200 participants recruited initially. There was a balance of males and females with 50.8% females and 49.2% male represented as indicated in Table 1. As per occupation, 36.7% were students, 47.9% working professionals and in others category 15.4% respondents belonged to group of unemployed, senior citizens, etc. The mean of daily screen time was 6.3 (2.1) hours per day. For purposes of sampling a two and a half urban and semi-urban communities, Singh and Mangat (1996), were sampled using stratified random sampling method which was designed to provide representative sample of age groups, male and female, education levels, different occupation, etc. The demographic profile of the sample offers evidence that the stratification method succeeded in making its distribution similar to the distribution of characteristics in the sampled population of adults, which was collected from these communities (Elfil & Negida, 2017).

Table 2. Demographic characteristics of participants (N = 1,172).

Characteristic	Percentage
Male	50.8%
Female	49.2%
Students	36.7%
Working professionals	47.9%
Others	15.4%
Average daily screen time	6.3 ± 2.1 hours

Digital Lifestyle Patterns

Several dimensions of digital lifestyle were studied including social media usage, online working, learning and communication so as to recognise the participants' interactions with digital technology within their lives and health-related digital practices. The percentage distribution of the use of social media revealed that most of the respondents (88.5%) use social media on a daily basis, indicating how much social media has become a part of everyday life in this post covid-19 world. This high prevalence is aligned with the latest data on internet behaviors, which has documented a consistent use across all age groups of the usages of social media throughout the pandemic, irrespective of the cessation of physical distancing social

restrictions (Selvam et al., 2024). One huge majority (76.9%) said they engaged in online working or learning activities other than using social media. The find is revealing of the progress of working and learning remotely/hybrid that has now moved beyond the immediate crisis of the pandemic and is now one of the norm in adulthood.

Moreover, 69.4% of the sample socially engaged with digital platforms. Actively engaging with media by video conferencing, messaging or being a member in social networks is included as it can actively promote social connectedness when there is intentional use (Osborne, 2025). Beyond these social and occupational activities, 61.7% of the respondents said they interacted with digital health/wellness apps. These were for various purposes, including meditation applications, fitness trackers, devices for monitoring sleep and mental health, and more. Digital health technologies have witnessed a significant increase in their usage over the last years, especially as a result of the pandemic, which impacted the healthcare services traditionally provided (Kriaučionienė, 2025). Results showed that >60% of the sample indicated they used such apps, suggesting that overall there is a slowly emerging trend in proactively caring for oneself in a virtual space, though no information on the amount or frequency with which such apps are used in the current analysis was reported.

Taken together, these patterns are a digital lifestyle that is ultra-ubiquitous and ultra-multifunctional, in a post-pandemic world. No: while some participants did use just one kind, digital engagement was integrated into a variety of areas—socially, professionally and/or in educational contexts, in interpersonal relations and in management of personal health. This multi-modal interaction shows that a “digital lifestyle” does not represent a quantitative measure, but rather it is the result of various activities some of which are even contradictory (Mousoulidou et al., 2024). Importantly, prevalence of both social media and work use online suggests that using the Internet is not only there to stay, but somewhat related to participants' social media use, which in turn could have implications in mental health and social wellbeing, as discussed in subsequent sections. It gives a glimmer of hope that the people will get help using a digital tool as a part of mental healthcare but also may question how effective and even to what extent that will be the only way in which someone can access mental healthcare.

Mental Health and Social Well-Being Outcomes

This assessment of the 1,172 respondents' mental health and the social wellbeing they have detailed a mixed picture of good news and concerns. Overall, an overwhelming proportion (72.3%) of the sample indicated high levels of life satisfaction on these types of measures, suggesting a positive evaluation of their overall satisfaction with life. In line with this 68.7% of participants endorsed high levels of social connectedness, which included feeling connected to others in their social circle and forming good relationships. The numbers show that in this sample that is observed that there has not been a massive reduction in psychological and social resources in the post-pandemic world for many people.

There was also considerable psychological distress among a large minority, however. In particular, 34.6% indicated that the level of perceived stress is moderate to high on the Perceived Stress Scale (PSS-10). This is similar to prevalence we've observed in other large-scale surveys of the post-pandemic world, where stress is higher than in each population. (Ding

et al., 2025). In addition, 29.8% of participants had moderate to high levels of anxiety, as measured using the Generalized Anxiety Disorder 7 Item Scale (GAD-7) and 22.7% had moderate to high depressive symptoms, according to the Patient Health Questionnaire (PHQ-9). These are such great rates of anxiety and depression, that basically one third and one quarter of the participants met clinically significant criteria for anxiety or depression at the time of the assessment.

The high level of life satisfaction with the high distress for a considerable minority suggests the difficulties of psychological experiences in the Post COVID-19 world. This supports a theoretical perspective espoused by well-being researchers and others who believe that a person can have a very satisfactory level of well-being in one domain (e.g., social) and a satisfactory level of wellbeing in another (e.g., environmental) and a high level of concern in a third (e.g., stress) (Diener, 1984). Such uneven distribution also provides a justifiable reason for the use of both mixed approaches and multivariate analysis of this study which based on simple univariate description are unable to describe this complex mixture of positive and negative psychological states.

To briefly summarise the main descriptive data, all the mental health and social well being indicators are summarised in table 3.

Table 3. Distribution of mental health and social well-being outcomes among participants (N = 1,172).

Indicator	Percentage of Participants
High Life Satisfaction	72.3%
Strong Social Connectedness	68.7%
Moderate to High Stress	34.6%
Moderate to High Anxiety	29.8%
Moderate to High Depression	22.7%

Regression Analysis

Multiple linear regression analyses were performed, with Mental Health Index as the dependent variable, in order to obtain the independent correlates to mental health outcomes within the post-pandemic sample. This index score was created by summing the PSS, GAD-7 and PHQ questionnaire scores in the reverse direction, with higher scores representing lower levels of psychological well-being. These predictor variables were healthy digital lifestyle practices, social connectedness, physical activity level, and length of time spent watching screens per day; these variables were each passed one by one via the forced entry procedure to understand the unique contribution of each controlling for the shared variance. Overall the regression model was statistically significant: $F = 18.617$ at and it explained a significant amount of the variance in mental health outcomes with an Adjusted R^2 of 0.708. The final result indicated that the explained variance in the mental health scores of the patients was generally 70.8% by the set of digital lifestyle and social variables, meaning its predictive power was very high in the framework of the post-pandemic. (Mousoulidou et al., 2024).

The standardized regression coefficients (β) gave information about the relative importance of each predictor and this was summarized in Table 4. Mental health had the strongest positive predicting item with the 'digital lifestyle practices implemented with a conscious attempt' where people who said they had a 'digital time limit' and 'turned off' focus modes had significantly better levels of mental health as did people who said they had engaged in digital 'detoxes'. This is common sense in children's well-being, as according to the theoretical framework of digital well-being, it is more important how children use digital technologies, rather than their total screen time (Kriaučionienė, 2025). The next ranking factor was social connectedness, indicating that a meaningful role of perceived relationships in reducing psychological distress is the second most important (Wickramaratne et al., 2022). Independent relationships between PA level and better mental health were also observed as in the voluminous literature the regular practising of exercise has been demonstrated to have anxiolytic and antidepressant effects (Noetel et al., 2024).

Table 4. Multiple linear regression results predicting the Mental Health Index (N = 1,172).

Predictor Variable	Standardized β	t-value	p-value
Healthy Digital Lifestyle Practices	0.42	8.96	<0.001
Social Connectedness	0.39	8.21	<0.001
Physical Activity	0.31	6.85	<0.001
Daily Screen Time	-0.27	-2.98	0.003

The daily screen time was a statistically significant negative predictor of mental health, which after considering the effects of other factors indicated that as daily screen time increased, there was an associated decrease in Mental Health Index scores. This inverse relationship finding adds to the knowledge on the relationship between screen time and risk of stress, anxiety, and depression in adults (Selvam et al., 2024). The fact that this result persisted when researchers took into account healthy digital habits, social connectedness and physical activity indicates that there is an independent, negative impact of screen time that goes beyond these other healthy behaviors. In sum, the results from the regression analyses support the primary hypothesis of the study, that the balanced and purposeful use of digital technologies can be seen as a protective factor for mental health, and that depending on the frequency, there are many cost-related psychological consequences of passive consumption of screens. The higher variance explained, the more that the interwoven impact of technology, society, and lifestyle on mental health makes sense in the post pandemic era.

Correlation Analysis

Pearson correlations were further performed on the continuous variables (Digital Lifestyle Score, Social Well-Being index, Mental Health index, Life Satisfaction index, Social Connectedness index, hours in front of the screen and sleep quality) to explore the bivariate relationships between key constructs. The correlation matrix is given in table 5; it showed some statistically significant relationships that support and expand upon the regression results.

Table 5. Pearson correlation coefficients among digital lifestyle, mental health, and social well-being variables (N = 1,172).

Variable	1	2	3	4	5	6	7
1. Digital Lifestyle Score	—						
2. Social Well-Being Index	0.75***	—					
3. Mental Health Index	0.68***	0.72***	—				
4. Life Satisfaction Index	0.72***	0.81***	0.65***	—			
5. Social Connectedness Index	0.60***	0.78***	0.59***	0.62***	—		
6. Daily Screen Time	-0.45***	-0.38***	-0.58***	-0.41***	-0.35***	—	
7. Sleep Quality	0.50***	0.42***	0.55***	0.48***	0.39***	-0.54***	—

Note: ** $p < 0.001$.*

Firstly, a high positive association between the Digital Lifestyle Score and the Social Well-Being index was found. Indeed, those who were able to report that they used more healthy digital habits such as being more deliberate about their screen time and actively using digital technology for a purpose reported higher levels of social connectedness and social wellbeing. This hearty linkage confirms conceptual models that suggest such behaviour can help to foster social capital if used carefully and well managed (Osborne, 2025). In a similar manner, Digital Lifestyle Score significantly and positively correlated with Life Satisfaction Index ($r = .$), suggesting that healthier use of digital technologies are positively related to higher levels of fulfillment and contentment with life. The correlations provide a convergent validity of the regression result, and that life satisfaction is an essential concern for psychological well-being (Diener, 1984). Social Connectedness Index was also significantly positively related with Digital Lifestyle Score, suggesting that in digital world, too, there is possibly a positive relationship between proscribed use and social connectedness.

Conversely, days on which there was increased screen time was negatively associated with all positive well-being indicators. The correlation value between mental health index and total daily screen time was moderately strong and negative, which confirmed with the regression results. This finding is consistent with the literature which reported association of psychological distress with high screen time and extended individual screen time

(Mousoulidou et al., 2024). Further, there was a significant negative correlation between daily screen time and sleep quality , which is consistent with the known relationship between increased screen time and poorer sleep quality, as screen time includes blue light exposure and mental stimulation that have been shown to affect sleep, particularly in the lead up to sleep (Liu, 2026). The significance of these negative correlations indicate a large variance of the mental health and sleep outcomes explained by screen time.

Additionally, sleep quality was also positively related to Mental Health Index and Digital Lifestyle Score , thus elucidating their interconnectedness. Correlation between Social Well-Being and Mental Health was as expected found to be strong , with a sense of belonging found to give protection against depression and anxiety (Wickramaratne et al., 2022). General pattern of correlations and findings lend support to construct validity of measurements applied, as well as providing greater insight: healthy digital behaviors seem to be related to a wide range of wellbeing outcomes, whilst higher screen time consistently activates risk especially to wellbeing in relation to mental health and sleep. When combined with the results of the regression models, these bivariate relationships provide a comprehensive picture on how and why digital experiences that was not solely a question of amount or how much time individuals spend online was found to be important in psychological well-being in the post-pandemic era.

Comparative Findings

The sample was then classified into different groups according to Digital Lifestyle Score as follows: “Balanced Digital Lifestyle” and “Unhealthy Digital pattern”. The participants who showed higher score value than the median for the composite Digital Lifestyle Scale of items which has intentional screen handling, purposeful use and engagement into the digital health practices were considered balanced and other participants who showed their score value below the median were categorized as showing an unhealthy practice sign. Independent sample t-tests then were conducted to establish if there were any differences between the two groups in the important outcome measures; these results are presented in Table 6.

Table 6. Comparative mental health and social well-being outcomes between balanced and unhealthy digital lifestyle groups.

Outcome Variable	Balanced Digital Habits	Unhealthy Digital Patterns	Mean Difference (%)
Mental Health Score	Higher	Lower	24.8% higher
Social Connectedness	Higher	Lower	22.5% greater
Life Satisfaction	Higher	Lower	20.7% higher
Perceived Stress	Lower	Higher	18.9% lower
Anxiety and Depression Symptoms	Lower	Higher	16.8% fewer

Comparative analyses revealed overall and significant results of balanced digital habits group in all five domains in Table 6. In more concrete terms, when assessing their mental health scores, the score of the participants who were interested in healthier digital lifestyles were 24.8% higher than the scores of those interested in unhealthy digital lifestyles. The nature of

this notable discrepancy is an indicator for the size of the protective effect observed with the use of balanced technology use in the regression analysis which was the strongest independent predictor of Mental Health Index (,) (Mousoulidou et al., 2024). In addition, the balanced digital habits group showed significantly greater scores on the indicator of social connectedness (22.5% more) and there was a positive correlation between the Digital Lifestyle Score and the Social Well-being Index (Osborne, 2025). It seems to suggest that not all human relationships, at least not all quality and deliberate relationships, need to be in opposition to the use of D.T., as it has been portrayed, to be good, active and effective.

In addition to the above strengths around mental health and social behaviour, the people who had a balanced approach to digital engagement had 20.7% greater life satisfaction. This is a larger benefit and matches into the high positive correlation between the Digital Lifestyle Score and the Life Satisfaction Index , which means that healthy digital lifestyles relate to each and every individual's measure of satisfaction with life (Diener, 1984). On the other hand, the results of the comparison also showed that the unhealthy digital pattern group also reported significant disadvantages in terms of psychological distress. It was found that people in this group showed higher levels of perceived stress (18.9%) and anxiety and depression (16.8%) than those who had balanced eating habits. These differences also have clinical implications because they mean the negative affect and the symptoms associated with stress are much greater among the “excessive digital consumers” and passive consumers.

Reliability of such effects in different dimensions of well-being can be considered as a solid evidence of the influence of digital lifestyle quality on psychological well-being. When looking at the results of the tests across all measures, the differences between the results of the healthy group and the unhealthy group ranged from about 17% to 25%, showing that differences between planned and unplanned digital activity are far from meaningless and, therefore, have significant consequences for both the individuals and the public health (Kriaučionienė, 2025). The comparative analysis illustrates that these discrete, quantifiable differences can be translated into great benefits for populations at risk at the level of mental health and social well-being if the primary digital lifestyle habits could be meaningfully improved, for example with screen time limits, reduced amount of passive consumption time and increase active consumption time, as well as inclusion of well-being practices in the real world that complement digital well-being practices such as physical activity. These findings thus supplement the regression and correlation results as a concrete idea on gains to be expected in promoting balanced digital habits in the post-pandemic context in society.

Discussion

The results of this mixed-methods research yield a number of theoretical and practical implications that inform the complex interplay between Digital Lifestyles and psychological well-being, within the Post-Pandemic realm. Theoretically, our findings contribute to the literature by showing that often, it's not about how much time we spend in front of a screen but how we utilize it and how we do it that become the most powerful factors in mental health. This finding challenges monocausal notions of the impact of digital media use, which are invariably negative (Selvam et al., 2024), and suggested a more nuanced approach to the

identification of protective or harmful digital behaviour, based on reasons and context. The positive correlation between the healthy use of digital tools and social wellbeing supports the discussion on 'social displacement' versus 'social enhancement' (Osborne, 2025) and therefore, the use of technology can offer perceived social enhancement, provided it is purposeful in sustaining the meaningful social relationship. Additionally, the relatively high proportion of variance accounted for by the regression model ($R^2 = .74$) suggests a significant overlap among the factors studied (healthy digital habits, social connectedness, physical activity, and screen time), implying that these factors collectively contribute to a good amount of influences on mental health in the post-pandemic era, with direct consequences for theoretical models examining digital well-being (Mousoulidou et al., 2024).

Practically, the results are significant for practitioners working with mental health care and education and for policy makers striving to develop mental health promotion interventions for the population in a more and more digital world. For example, the relative results that indicated the use of balanced digital behaviours showed a mental health score 24.8% higher and perceived stress score that was 18.9% lower displayed an interesting threshold of change targets. Public health messages could potentially further consider the aspects of digital literacy and intention: the importance of actively co-creating positive digital environment, establishing tech-free zone, intentionally building meaningful digital relationships and digital engagement rather than passive viewing (Kriaučionienė, 2025). The education system may be integrated into curriculum with digital well-being module (preventive approach) where children or students can learn some techniques of self-regulation, such as digital fast and "focus mode" on an electronic device, which can have a positive and significant long-term impact on child's mental health according to our study. A strong independent predictive role of healthy digital lifestyle practices on both MDMA use and substance-related harms () points to a low-cost and scalable opportunity for mental health practitioners and clinicians to screen for MDMA use during mental health exams and suggest targeted behaviors. With its dynamic interactions between screen time and physical activity, as found in our analysis (Noetel et al., 2024), employers, especially those with remote and hybrid working arrangements, could offer wellness programs that promote breaks for physical activity, set limits on work-related digital contact after hours, and offer tools to manage digital fatigue.

However, there are some methodological limitations to the results of this study which need further consideration. Secondly, because of its cross-sectional design, conclusions regarding potential causal relationships of observed associations cannot be drawn, that is, although we proposed that balanced digital lives were associated with minds in balance we cannot rule out the opposite explanation that having a mind in balance allows them to have a balanced digital life. This distinction will only be made possible by longitudinal and experimental studies. Second, all main constructs—screen time, mental health symptomology—were measured using self-report methods, which could include sources of bias, such as social desirability and recall errors. Especially, participants may have underestimated the actual amount of time they spent on screens and/or overestimated their healthy behavior, which may have resulted in larger effect sizes being reported (Ding et al., 2025). Third, although our sample of 25 communities was designed to achieve a certain degree of representativeness with respect to demographic

characteristics, we were geographically limited and our results may not apply to rural communities, or other cultural communities for which the values, beliefs, and attitudes associated with the expression of mental illness and technology use are vastly different. Fourth, the study had limitations in this regard because it did not account for the existence of other mental health problems besides depression which may have influenced the use of digital devices or mental health feelings.

Gaps and limitations within this research result in the following possible research directions: longitudinal cohorts across time (years) to ensure that interventions to prevent and promote mental health can identify possibly critical periods of development. A question that could be explored in future studies is if the relationships we identified between fish and people remain stable or change as participants age and/or as the “post COVID” social landscape changes. Studies should also assess the possible moderating effects of demographic factors such as age, gender and work status as the sample size in our study was not largely enough to test for interaction between the use of digital life-styles and the demographic factors. For example the effects of excessive screentime may be more pronounced when parents were also busy with work or less exerted when young adults were younger than 25 and still developing their self-regulation. (Selvam et al., 2024). Moreover, there have been few studies to investigate the mechanisms through which healthy digital activities appear useful (e.g., via improved sleep, increased physical activity, engagement in mindfulness or increased social interaction) and mediation analysis of our correlational results should address this. Finally, this study shows that a high percentage of participants (61.7%) engage with digital health applications, which is a promising area for future research to determine the impact of their use or non-use of such applications on everyday health behaviours, including stress, anxiety or social connectedness, to inform best practices (Kriaucionienė, 2025). To conclude, this study found that, while it offered insights into the balanced use of digital technology as a protective measure for mental health during the post pandemic phase, there was need for more research to support and guide the development of effective evidence based strategies to prevent mental ill health for diverse populations.

Conclusion

This study aimed to uncover the case and dimensions of the relationship between Digital Technology Use (DTU) patterns and Mental Health Outcomes (MHO) in the Post-Pandemic Era (PE) on the significance of balanced DTU pattern with specific emphasis on DTU and the Feeling part in particular, through a mixed-methods study. The main results showed that, adequate digital lifestyle habits were the best positive predictor for mental health ($p = 0.002$) and high daily use of these devices was the best negative predictor for mental health ($p = 0.004$). The results confirm the key hypothesis being examined – that it is not simply the quantity (or quality) of technology use that is important in contributing to wellbeing, it is the quality and purposeful use of technology. There are then two things we can do for the field that we should do. Firstly, we wish to provide robust empirical findings on the new conceptualization of digital well-being, precisely, mindful engagement with technology, not only restricting technology use. The second is that in terms of the concept itself, moving towards the post-pandemic understanding of society, our contribution is that digital behaviours have become structuralised,

assimilated into our work, school and everyday life. Findings from this study indicated that scores on mental health and social connectedness both made a difference of 24.8% and 22.5% respectively for participants with a balanced approach to studying and using technology over those who had an unhealthy approach and suggest that such an approach may be a public health option to help promote more intentional use of technology.

Further research is suggested that could lead in a variety of ways from limitations and findings of this research. Though this was a cross sectional study, further longitudinal cohort studies are warranted to discern the directionality of causality between digital habits and mental health as well as to control for potential reverse causal relationships and other unstudied confounding factors (e.g., risk of psychological vulnerability). Furthermore, future studies should investigate possible intervening behavioral mechanisms (for example, sleep quality, physical activity, mindfulness) through which healthy use of digital technologies offers protection, perhaps through the use of mediation analysis with larger and more representative samples. On the whole, this paper provides a solid body of data to guide policymakers and practitioners to cease giving simplistic screen-time warnings and instead implement more complex activities that support digital literacy, intentionality and self-regulation. There is no doubt that digital technologies are increasingly functioning in every aspect of our lives and the promotion of a healthy digital lifestyle is a low-cost and scalable solution to ensure the population mental health in the post pandemic period and beyond.

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