

Humanizing online pedagogy with stream: the mediating role of students' sense of agency within the community of inquiry

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ABSTRACT

This study explores whether students' sense of agency mediates the relationship between stream integration and the three presences of the community of inquiry (CoI) framework, namely, cognitive, social, and teaching presence in online higher education. A cross-sectional survey design was employed to undergraduates ($n=107$) from four Malaysian universities by validated instruments for data collection, measured stream integration, sense of agency, and CoI presence. PLS-SEM was employed for data analysis using SmartPLS 4 software, adhering to a two-step process. Stream integration significantly predicted cognitive ($\beta=0.573$), social ($\beta=0.405$), and teaching presence ($\beta=0.433$), as well as sense of agency ($\beta=0.497$), all $p<0.001$. Agency, in turn, predicted the three presences ($\beta=0.281-0.371$, $p<0.001$). Indirect effects confirmed partial mediation, with variance accounted for (VAF) ranging from 27% to 32%. Theoretically, these findings extend the CoI framework by establishing sense of agency as a critical mediating construct. Practically, the study contributes to humanizing pedagogy design in higher education by demonstrating how stream-based designs foster psychological empowerment. The results suggest that embedding authentic choice, authorship, and interdisciplinary tasks can strengthen student agency, ultimately humanize the online learning experience and enhance overall learning presence.

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1. INTRODUCTION

Despite the rapid growth of online higher education, there is an urgent need for pedagogical approaches that humanize digital learning environments, as learners continue to report experiences of disconnection, limited interaction, and reduced engagement [1] Since COVID-19, online and blended learning have undoubtedly expanded access and flexibility, enabling students to learn across time and space, but these advantages have often been accompanied by challenges of isolation and reduced sense of belonging [2]–[4].

In particular, the absence of face-to-face meetings in digital communication can make learners feel like passive recipients rather than active participants [5]. Moreover, engaging participation needs a humanized approach by educators rather than active learning in an online learning environment [6], [7]. To address this, scholars have argued for humanizing pedagogy approaches, which need to consider the learner as a person, emphasizing agency, identity, and relationality in the learning process is still inconclusive [8], [9]. In this sense, how humanization can be empirically examined and embedded into online higher education design.

The community of inquiry (CoI) framework has become a prominent adopted model to measure perspectives of online learning, emphasizing the interplay of cognitive, social, and teaching presence [2]. According to Garrison and Vaughan [2], cognitive presence refers to the extent to which learners construct and confirm meaning through reflection and discourse; social presence refers to the ability of learners to project themselves as “real people” in an online environment, expressing emotions, building trust, and fostering collaboration [10]; and teaching presence refers to the design, facilitation, and direction provided by instructors that structure and support the learning process [11]. CoI has been extensively validated across disciplines and contexts, providing a robust model for analyzing and improving online learning [1]. However, the framework has also been critiqued for offering limited insights into the psychological processes, as it can be descriptive of presences that emerge [11]. Thus, there is a need to investigate another construct, which is the mediating mechanisms that connect instructional design to the development of these presences.

For greater nation-building, it is highly dependent on creative, innovative, and critical thinking that leads to problem-solving citizens [12]. Hence, integrating stream into the curriculum for nurturing talent is crucial. Higher education is also no exception to adopting a humanized online learning approach. However, limited research has been conducted in higher education that focuses on humanizing online learning in stream. In this sense, stream pedagogy is expanding science, technology, engineering, and mathematics (STEM) to include reading and arts and has emerged as a promising design paradigm that promotes critical thinking, creativity, interdisciplinarity, and authentic problem-solving. Stream situates learning in real-world, complex contexts that require not only technical competence but also critical analysis, creativity, and communication [13], [14]. It has been widely applied in preschools to secondary schools, where it has been shown to enhance learner engagement, motivation, and problem-solving skills [13], [14]. However, digital tools and their application in online environments remain limited, especially in higher education. Incorporating stream into digital courses by embedding learning tasks that are interdisciplinary, meaningful, and student-centered would provide a systematic approach to enrich the CoI presence. In this sense, stream has the potential to shift online learning from knowledge transmission towards active, human-centered knowledge construction.

Another construct that is critical but often overlooked in online learning is the learner’s sense of agency. The sense of agency can serve as a key psychological bridge between design and experience that reflects the perception of having choice, control, and authorship in learning activities. Agency refers to a basic psychological need and has roots in Bandura’s [15] notion of human agency and is central to self-determination theory (SDT) [16]. In educational contexts, agency reflects students’ capacity to influence their own learning pathways, make meaningful choices, and contribute original ideas [17]. However, online learning environments vary in the extent to which they support or suppress agency. In addition, tasks that invite self-direction, authorship, and collaboration can enhance it, but over-structured or instructor-driven designs can diminish students’ sense of ownership. Theoretically, in designing to humanize pedagogy, agency may function as the missing psychological mechanism that explains how stream-based learning designs foster the CoI presence.

Despite the rapid growth of online higher education, there is an urgent need for pedagogical approaches that humanize digital learning environments, as learners continue to report experiences of disconnection and reduced engagement. While frameworks like the CoI provide a robust taxonomy of cognitive, social, and teaching presences, they have been critiqued for being primarily descriptive and offering limited insights into the underlying psychological mechanisms that activate these presences [1]. A significant research gap exists in understanding how multidisciplinary design innovations, such as stream integration, catalyze these presences through internal learner empowerment. While previous research confirms that stream—which expands STEM to include reading and arts—can improve engagement in school-level or face-to-face contexts, its application and impact within online higher education remains underexplored [1]. Furthermore, the ‘sense of agency’ is often highlighted as a critical psychological bridge between design and experience, yet it is seldom empirically tested as a mediator in online learning models.

The novelty of this study lies in its shift from a descriptive to an explanatory model by introducing ‘sense of agency’ as a mediating construct within the CoI framework. By doing so, the research provides a psychological explanation for how teaching presence and stream-based designs translate into cognitive and social engagement. This study is among the first to operationalize ‘humanizing pedagogy’ in measurable, quantitative terms by linking stream design, agency, and learning presence in a digital university

environment. Consequently, these findings contribute to a new theoretical understanding of how interdisciplinary integration serves to humanize online pedagogy through the promotion of student authorship, choice, and empowerment.

This study addresses this gap by offering new insights into how online pedagogy can be designed to be both effective and humanizing with examining how students' sense of agency mediates the relationship between stream integration and the CoI presences. In addition, this study extends the CoI framework that provides a comprehensive theoretical underpinning of how design translates into experience by incorporating sense of agency as a mediating construct. The researchers also empirically operationalize the concept of humanizing pedagogy by linking it to measurable constructs, namely, stream design, agency, and learning presence within higher education online contexts. In this study, 'humanization' is operationalized at the intersection of agency and the CoI framework. It is defined as a move away from passive content consumption toward psychological empowerment (agency). Specifically, humanization is achieved when stream-based designs allow students to project their unique identities (social presence), take ownership of their learning paths (agency), and engage in collaborative knowledge construction (cognitive presence). Thus, agency is the primary indicator of a humanized pedagogy, while the three CoI presences serve as the environmental evidence of its success. Finally, the researchers enable instructors to design courses that are not only efficient but also deeply human-centered by offering evidence-based strategies for embedding agency into course design through stream activities.

2. LITERATURE REVIEW

2.1. Humanizing pedagogy in online higher education

Humanizing pedagogy in online environments has become a critical concern in higher education. Rooted in the work of Freire [8], humanizing pedagogy emphasizes treating learners as active agents rather than passive recipients of knowledge. It foregrounds dialogue, empowerment, and recognition of learners' socio-cultural identities. In digital contexts, humanization entails designing environments where learners' voices, choices, and identities are acknowledged and where socio-emotional connections complement cognitive development [3], [9].

Online higher education has often been critiqued for its transactional nature, where content delivery and assessment take precedence over relationships and identity development [2]. In this sense, humanizing pedagogy offers a counter-narrative, urging educators to design courses that foster a sense of belonging, encourage authorship, and promote personal investment. Scholars argue that the absence of humanization may lead to disengagement, high attrition, and limited transfer of learning to authentic contexts [18]. However, despite its importance, humanization has often remained conceptual rather than empirically tested. Thus, this study contributes by embedding humanizing pedagogy within measurable constructs: stream design, sense of agency, and the CoI presence.

While science, technology, engineering, arts and mathematics (STEAM) integrates the arts to foster creativity, stream explicitly incorporates 'reading' to address the critical literacy demands of higher education. In a digital learning context, 'reading' extends beyond basic comprehension to include the critical evaluation of multimodal texts and disciplinary discourses. This inclusion is theoretically justified as it provides the cognitive tools necessary for students to exercise agency; without the literacy to navigate and critique information, students cannot effectively act as co-creators in the CoI.

2.2. Pedagogical empowerment by integrating of stream and agency within the CoI framework

The CoI framework provides a robust lens to study the quality of online learning environments [2]. Extensive studies from a systematic literature review validate that the CoI framework across disciplines [1]. Research shows that the three presences predict learning outcomes, satisfaction, and retention [1]. Nevertheless, critiques highlight that CoI is primarily descriptive and does not always explain why presences emerge in certain designs and not others [2]. Scholars increasingly call for integrating CoI with psychological theories to capture underlying mechanisms [4]. This study offers explanatory power beyond description by introducing a sense of agency as a mediating construct.

Stream extends STEM education to foster interdisciplinarity, creativity, and holistic problem-solving by incorporating reading and arts, conceptualized as STEAM [13]. The expanded stream model emphasizes literacy, critical thinking, and creative expression for technical learners [19]. Stream tasks often require learners to draw upon multiple domains, integrate diverse perspectives, and generate original artifacts.

Empirical studies have shown that stream enhances engagement, critical thinking, and collaboration in school contexts [13], [14]. In this sense, stream promotes 21st-century skills such as creativity, communication, and adaptability [14]. However, most research focusing on STEM or STEAM that reflects the application of stream in higher education remains underdeveloped. Moreover, despite its potential to counteract passivity and disengagement, its integration into online learning contexts is rare.

Stream tasks could serve as design features that strengthen the CoI presence in online learning environments for higher education, such as interdisciplinary projects foster cognitive presence by requiring integration and resolution of diverse ideas. Collaborative tasks stimulate social presence by necessitating communication and trust-building across disciplines. Instructor scaffolding in online stream-based environments enhances teaching presence by guiding complex projects. A dual approach to humanizing pedagogy by embedding choice and creativity, stream may also foster students' sense of agency.

According to Bandura [15], sense of agency refers to the subjective experience of controlling one's actions and their consequences. In educational contexts, it reflects learners' perceptions of autonomy, authorship, and responsibility [17]. Agency differs from related constructs such as motivation or engagement, which emphasize control and authorship rather than effort or persistence. According to SDT [16], agency is the central autonomy of a basic psychological need. For example, when learners perceive choice and control, they experience greater intrinsic motivation, persistence, and deeper learning, rather than environments that restrict agency may foster compliance but undermine ownership.

In online learning, an agency navigates complex technologies, and self-regulating learners' progress is critical because they often work asynchronously [20]. Previous study urges that students are likely to engage socially and cognitively when they feel they can shape their learning process [13]. However, agency has rarely been studied as a mediator between design features and learning outcomes. Thus, this study highlights its role as a psychological conduit translating design into presence by positioning the agency between stream and CoI.

2.3. Research hypotheses

To examine the relationships within the conceptual framework, seven research hypotheses were developed as:

- There is a significant relationship between the stream integration and the teaching presence among the students (H1).
- There is a significant relationship between the stream integration and the cognitive presence among the students (H2).
- There is a significant relationship between the stream integration and the social presence among the students (H3).
- There is a significant relationship between stream integration and the sense of agency among the students (H4).
- There is a significant relationship between the sense of agency and the teaching presence among the students (H5).
- There is a significant relationship between the sense of agency and the cognitive presence among the students (H6).
- There is a significant relationship between the sense of agency and the social presence among the students (H7).

2.4. Integrating stream, agency, and CoI: towards humanizing pedagogy

The integration of stream, sense of agency, and CoI provides a novel framework for operationalizing humanizing pedagogy in online higher education. CoI identifies the structural elements of presence, rather than agency represents the learner's psychological response, perceiving autonomy, control, and authorship in stream tasks. In fact, CoI does not account for the psychological mechanisms that enable these presences. stream provides the design features that make learning authentic, interdisciplinary, and creative. In this sense, constructs explain how design translates into meaningful learning presence, thereby humanizing the online experience. Empirically, this integration addresses multiple gaps: i) it extends CoI with a mediating construct, responding to calls for deeper theoretical grounding and ii) it operationalizes humanizing pedagogy by linking it to measurable constructs that can be reflected in the theoretical framework and conceptual framework sections.

2.5. Theoretical framework

In this research, the theoretical framework draws from the CoI model to investigate whether students' sense of agency mediates the relationship between stream integration and the three presences of the CoI model in online higher education. The CoI model focuses on cognitive presence, social presence, and teaching presence, providing a structured approach to understanding teaching and learning engagement within an online learning environment [4]. In addition, stream integration is underpinned by STEM pedagogical knowledge and has been shown to enhance instructional practices by giving necessary competencies for active technology-enhanced learning to educators [13]. This is also complementary to the concept of a "sense of agency",

which is included in this theoretical framework that highlights the importance of perceived control or gained control over in learning and teaching experience. Thus, helping both students and educators take an active role during learning and teaching experience [17]. Together, these strands provide the conceptual basis for understanding how instructional design can humanize online learning in higher education. Therefore, the theoretical framework for this research was developed as shown in Figure 1.

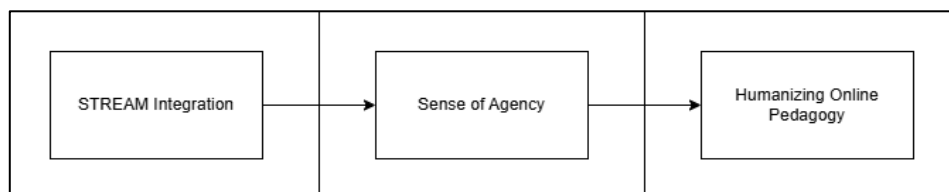


Figure 1. Theoretical framework for humanizing online pedagogy

2.6. Conceptual framework

The conceptual framework related to students, as shown in Figure 2, reflects the hypothesized relationships that refer to the independent variable for this research, which is stream integration and focusing on enhancing teaching presence, cognitive presence, and social presence within humanizing online pedagogy [13], [21]. The sense of agency is positioned as a mediating factor and is hypothesized to influence how effectively stream integration humanizes online pedagogy. This approach will guide the research in exploring how stream and the sense of agency can work together to foster a more supportive, interactive learning environment in higher institutions and align with humanizing teaching and learning practices [11]. Humanization is thus operationalized as the strengthening of these presences through stream and agency. Thus, Figure 2 (graphical model): stream integration (design) influences students' sense of agency (psychological mechanism), which in turn contributes to the CoI presence (learning outcomes). Humanizing pedagogy is represented as the overarching outcome of this process.

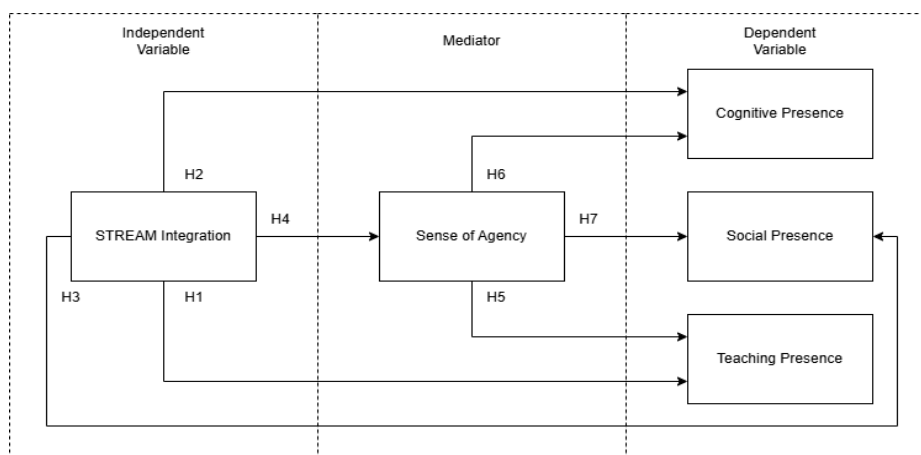


Figure 2. Conceptual framework humanizing online pedagogy for students

3. METHOD

3.1. Research design

This study employed a quantitative, cross-sectional survey design to explore whether students' sense of agency mediates the relationship between stream integration and the three presences of the CoI framework, namely cognitive, social, and teaching presence. The design was chosen for its suitability in testing theoretically grounded structural relationships among latent constructs using partial least squares structural equation modeling (PLS-SEM) [22]. PLS-SEM was selected as its capacity not requiring multivariate normality to handle complex models with multiple constructs and mediating pathways in relatively small samples [23], and appropriate for education research as constructs are theoretically under development, and sample sizes are often modest.

3.2. Sample size

A priori power analysis was conducted using G*Power version 3.1.9.4 to determine the minimum required sample size for a linear multiple regression model [24]. The analysis was based on the following parameters: a medium effect size ($f^2=0.15$), a conventional alpha level ($\alpha=0.05$), and a desired statistical power ($1-\beta$)=0.95. The model includes two predictors.

The analysis results shown in Figure 3 yielded a required total sample size of 107 participants, ensuring a 95% probability of detecting an effect of at least medium magnitude, should it exist in the population. The noncentrality parameter (λ) was 16.05, with a critical F-value of 3.08. The degrees of freedom were 2 (numerator) and 104 (denominator), respectively. This ensures that the study is sufficiently powered to avoid Type II error under the specified conditions. These parameters align with Cohen [25] guidelines for power analysis in behavioral and social sciences, enhancing the statistical robustness and validity of the planned regression analysis.

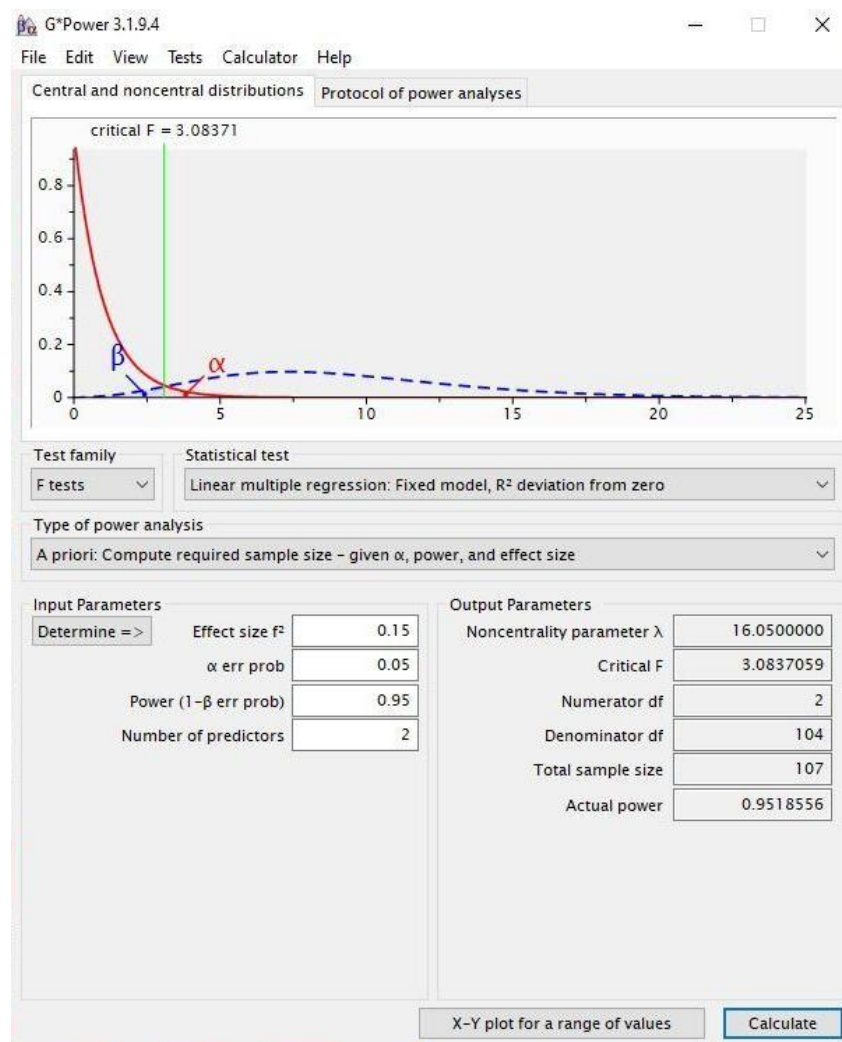


Figure 3. G*Power version 3.1.9.4 results

While the sample size of $N=107$ may appear modest, it is statistically sufficient for the requirements of PLS-SEM. According to the '10-times rule' and the more stringent inverse square root method [23], a sample of 107 provides adequate power (>0.80) to detect path coefficients of 0.25 at a 5% significance level. Furthermore, the use of SmartPLS 4 utilizes bootstrapping techniques with 5000 resamples to ensure the stability of the estimates and mitigate the risks associated with smaller sample sizes.

The representativeness of the sample is supported by the homogeneity of the target population—undergraduates enrolled in interdisciplinary stream-based modules across four major Malaysian universities.

By utilizing a purposive sampling technique, the study ensured that all participants had direct exposure to the phenomena under investigation (stream and online CoI). This targeted approach reduces 'noise' in the data, allowing for meaningful structural modeling even with a more focused participant pool. In addition, given that this study introduces a novel mediating construct (sense of agency) into the CoI framework, it serves as a foundational explanatory model. The multi-university involvement (four institutions) ensures that the findings are not idiosyncratic to a single institutional culture, providing a geographically diverse snapshot of the Malaysian higher education landscape.

3.3. Participants and sampling

The study represented both public and private universities, conducted across four Malaysian higher education institutions. Based on the Ministry of Higher Education Malaysia (MoHE), the population of students currently enrolled in four universities selected for this study is 61,701, comprising Universiti Pendidikan Sultan Idris (UPSI) (29,409), Universiti Teknologi MARA (UiTM) (23,066), SEGi University (SEGi) (6,343), and UNITAR International University (UNITAR) (2,883) students (MoHE, 2023). The inclusion criteria for students to be selected are: i) students are currently enrolled at either UNITAR, SEGi, UiTM, and UPSI, and ii) students have experience with online learning or blended learning formats. A stratified random sampling technique was applied to ensure diversity in STEM-related, social science, and humanities programs and capture representation across disciplines. Based on a prior power analysis, the total sample ($n=107$) was allocated to the four universities respective to their student population: UPSI ($n=42$), UiTM ($n=40$), SEGi ($n=11$), and UNITAR ($n=14$).

3.4. Instrumentation

The survey instrument was adapted from validated scales in prior research. All items used a 5-point Likert scale (1=strongly disagree to 5=strongly agree). The survey instrument was aligned with the CoI framework as a core theoretical framework. A set of questionnaires comprising three main constructs: stream integration, sense of agency, and the three presences (cognitive, social, and teaching presence). The stream integration items were adapted from previous research [13], [21]. The sense of agency items was adapted [17]. The cognitive presence, social presence, and teaching presence items were adapted from [4], [12]. All items were modified to suit the present research context and aligned with the theoretical framework and the conceptual framework. The questionnaire was separated into seven sections, which were demographic, stream integration, sense of agency, cognitive presence, social presence, teaching presence, and an open-ended question.

3.5. Validity procedures

The survey instrument involved content validity and pilot testing. Content validity encompassed three experts in educational technology who reviewed items for clarity and alignment with constructs. Content validity index (CVI) scores exceeded 0.80 for all items. Pilot testing was conducted with 25 undergraduates; Cronbach's α values >0.70 confirmed preliminary reliability. Minor adjustments to wording improved clarity for the local context.

3.6. Procedure and ethics

Data were collected via an online questionnaire distributed via learning management systems, social media, official text messenger, and mailing lists through the gatekeepers of each university. Participation was voluntary, and students were informed that their responses would remain anonymous. Digital informed consent was designed within the online questionnaire for them to consent to their data being shared in public or anonymously. The online questionnaire utilized mandatory response fields for all items, resulting in a complete dataset with no missing values. Consequently, no imputation or data suppression techniques were required, ensuring that the final analysis was based on the full sample of $N=107$. Ethics approval was secured from the UPSI human research ethics committee (approval ID: [2025-0643-01]). Data were stored securely, with access restricted to the research team.

4. RESULTS

The conceptual framework of the study was assessed using PLS-SEM. The reliability and validity of both the measurement and structural models were evaluated for significance and overall fit. PLS-SEM, also known as SEM, is a variance-based path modeling technique that aims to optimize the explained variance by independent variables without the presumption of normal data distribution. This method is making it a favored approach among researchers in the social sciences as it is applicable for studies with small sample sizes [26]–[28]. Its adoption has surged in recent years, with many studies leveraging the PLS methodology [29], [30]. The analysis of the dataset was conducted using SmartPLS 4 software, adhering to a two-step

process, which is measurement then structural model [27], [28]. Before conducting the analysis on the dataset using SmartPLS, data screening was carried out to evaluate missing data and potential common method bias. Missing value analysis (MVA) was executed using SPSS, revealing that no missing values were present in any of the observed variables. Consequently, all cases were included in further analyses without the need for imputation or deletion. To examine the potential existence of common method variance (CMV), Harman's single-factor test was performed through an unrotated exploratory factor analysis encompassing all measurement items, a standard initial check for method bias [31]. The analysis showed that the largest single factor explained 37.995% of the total variance, which is below the generally accepted 50% threshold and the more stringent 40% benchmark suggested in recent methodological research [32], [33]. These findings suggest that no single factor dominated the variance structure, indicating that common method bias is unlikely to significantly affect the validity of the study's results.

4.1. Evaluation of measurement model

Initially, the validity and reliability of the constructs were evaluated. The internal consistency was measured using Cronbach's alpha and composite reliability (CR). Hair *et al.* [34] recommend a CR value above 0.7, which also applies to Cronbach's alpha. As shown in Table 1, all constructs in this research met the internal consistency criteria. Next, convergent validity was assessed by determining the average variance extracted (AVE) for each construct, with a minimum threshold of 0.5 as advocated by Fornell and Larcker [35]. Table 1 indicates that this criterion was satisfactorily met in the current analysis. The reliability of the indicators was checked through item loadings [29], [30], [34], with Table 1 retaining items that had loadings of 0.6 or higher [36].

In addition to the previous validity evaluations, discriminant validity was analyzed to ensure that the correlations between the measures of different constructs conformed to the approach outlined [37]. The Fornell and Larcker [35] criterion was employed for this assessment. As shown in Table 2, the square root of the AVE for each construct surpassed the intercorrelations with other constructs in the model, as shown in Table 2. Figure 4 depicts the measurement model of the proposed conceptual framework.

Table 1. Measurement model

Construct	2nd stage	No of items	Outer loading	R ²	Cronbach alpha	CR	AVE
Stream integration	Cognitive presence	13	0.691-0.832	0.247	0.941	0.943	0.587
Sense of agency		6	0.672-0.845		0.837	0.842	0.554
Triggering events		3	0.824-0.883		0.892	0.895	0.756
Exploration		4	0.766-0.868				
Integration		3	0.814-0.874				
Resolution	Social presence	4	0.826-0.875	0.452	0.799	0.801	0.713
Affective expression		2	0.872-0.888				
Open communication		3	0.784-0.877				
Group cohesion	Teaching presence	3	0.799-0.904	0.406	0.910	0.913	0.848
Design and organization		4	0.850-0.896				
Facilitation		6	0.749-0.878				
Direct instruction		4	0.820-0.868				

Table 2. Discriminant validity

Construct	Cognitive presence	Sense of agency	Social presence	Stream integration	Teaching presence
Cognitive presence	0.869				
Sense of agency	0.565	0.745			
Social presence	0.755	0.573	0.844		
Stream integration	0.713	0.497	0.590	0.766	
Teaching presence	0.768	0.514	0.710	0.581	0.921

4.2. Evaluation of structural model

The structural model was assessed utilizing a bootstrapping procedure with 5000 resamples for hypothesis testing. Initially, collinearity was examined, revealing VIF values for all constructs below 5. Subsequently, the coefficient of determination (R²) was evaluated using the PLS algorithm (Figure 1). The results show that the model explains 24.7% of the variance in sense of agency (R²=0.247), 56.7% of the variance in cognitive presence (R²=0.567), 45.2% of the variance in social presence (R²=0.452), and 40.6% of the variance in teaching presence (R²=0.406). These values suggest that the model demonstrates a moderate level of explanatory power for sense of agency, social presence, and teaching presence, while showing a substantial explanatory power for cognitive presence.

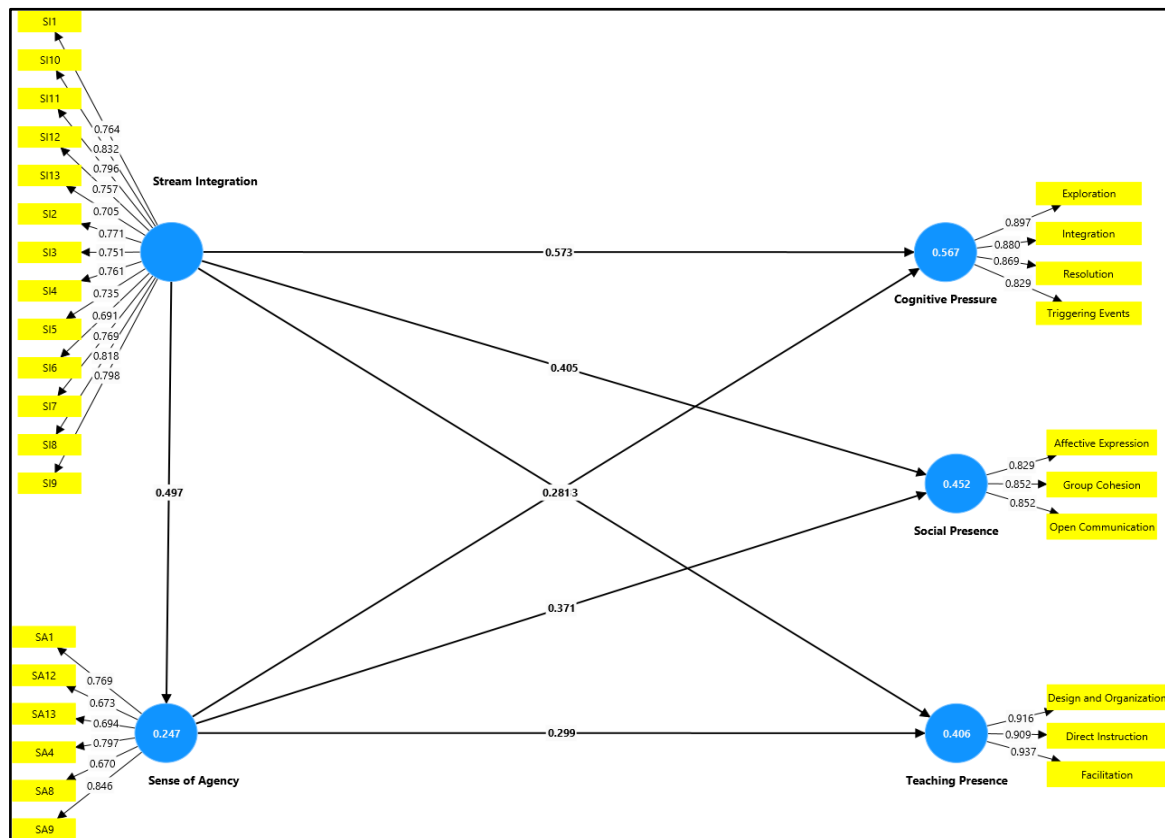


Figure 4. Measurement model

The path coefficients further indicate that stream integration has significant positive effects on cognitive presence ($\beta=0.573$, $p<0.001$), social presence ($\beta=0.405$, $p<0.001$), teaching presence ($\beta=0.433$, $p<0.001$), and sense of agency ($\beta=0.497$, $p<0.001$). In addition, sense of agency exerts significant effects on social presence ($\beta=0.371$, $p<0.001$) and teaching presence ($\beta=0.299$, $p<0.001$). Overall, these findings highlight that stream integration and sense of agency are important predictors of teaching, cognitive, and social presence within the model. Table 3 presents the corresponding t-statistics and P-value for the β -value, which determine the significance of the proposed relationship between constructs in the structural model, as shown in Figure 5.

The values in Table 3 confirm that stream integration significantly enhances cognitive presence ($\beta=0.573$, $t=8.541$, $p<0.001$), social presence ($\beta=0.405$, $t=5.936$, $p<0.001$), and teaching presence ($\beta=0.433$, $t=7.705$, $p<0.001$). These findings underscore the crucial role of stream integration in fostering deeper cognitive engagement, enhancing social interactions, and improving the quality of teaching support in online learning environments. Furthermore, stream Integration is a significant predictor of sense of agency ($\beta=0.497$, $t=6.764$, $p<0.001$), which in turn positively influences cognitive presence ($\beta=0.281$, $t=3.778$, $p<0.001$), social presence ($\beta=0.371$, $t=6.569$, $p<0.001$), and teaching presence ($\beta=0.299$, $t=4.694$, $p<0.001$). This suggests that students who cultivate a stronger sense of agency through stream-based learning are more likely to engage actively, collaborate meaningfully, and respond effectively to teaching support. Overall, the findings affirm that stream Integration is a pivotal factor in promoting teaching, cognitive, and social presence, thereby enhancing the humanization of online pedagogy.

The mediation analysis results, as presented in Table 4, indicate that sense of agency significantly mediates these relationships. Specifically, stream integration shows a notable indirect effect on teaching presence through sense of agency ($\beta=0.149$, $t=4.126$, $p<0.001$), on cognitive presence through sense of agency ($\beta=0.139$, $t=2.800$, $p=0.005$), and on social presence through sense of agency ($\beta=0.184$, $t=4.749$, $p<0.001$). These results imply that sense of agency construct as a vital psychological mechanism through which stream Integration enhances student engagement in online learning. For example, as students experience greater control, ownership, and responsibility in their learning (sense of agency), the benefits of stream Integration effectively translate to their perceived teaching support, cognitive engagement, and social connectedness in online pedagogy. Thus, the study confirms that sense of agency serves as a crucial mediator, contributing to

the humanization of online learning by amplifying the positive effects of stream integration. Finally, the researchers assessed all q-square values to determine the predictive ability of the model, all of which were found to be greater than 0. The findings suggest that the q-square value exceeds zero [30]. Therefore, the researchers conclude that our model possesses predictive relevance.

Table 3. Analysis of structural model

	Hypotheses	Path coefficient	T statistics	P values	Decision
H1	Stream integration → teaching presence	0.433	7.705	p<0.001	Supported
H2	Stream integration → cognitive presence	0.573	8.541	p<0.001	Supported
H3	Stream integration → social presence	0.405	5.936	p<0.001	Supported
H4	Stream integration → sense of agency	0.497	6.764	p<0.001	Supported
H5	Sense of agency → teaching presence	0.299	4.694	p<0.001	Supported
H6	Sense of agency → cognitive presence	0.281	3.778	p<0.001	Supported
H7	Sense of agency → social presence	0.371	6.569	p<0.001	Supported

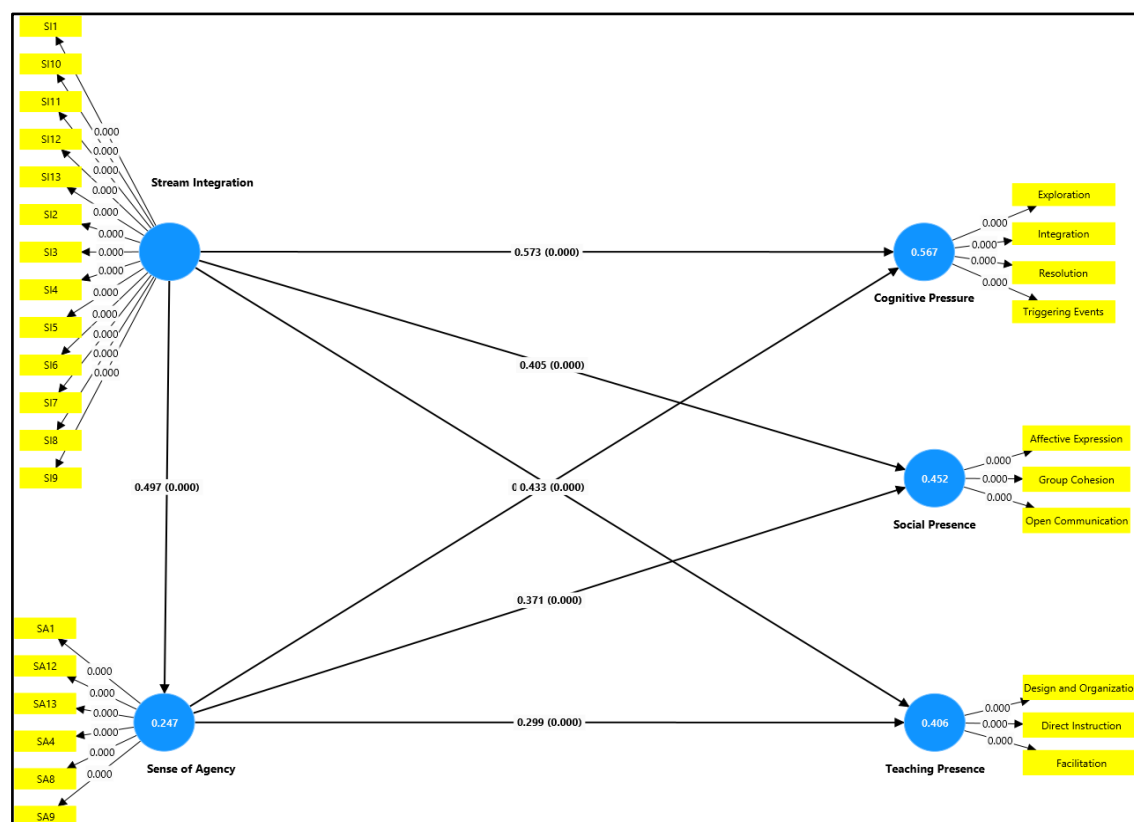


Figure 5. Structural model

Table 4. Mediating role of a sense of agency

	Hypotheses	Path coefficient	T statistics	P values	Decision
H8	Stream integration → sense of agency → teaching presence	0.149	4.126	p<0.001	Supported
H9	Stream integration → sense of agency → cognitive presence	0.139	2.800	0.005	Supported
H10	Stream integration → sense of agency → social presence	0.184	4.749	p<0.001	Supported

In conclusion, the results provide robust support for the hypothesized model. Stream integration directly enhanced all three CoI presences and students' sense of agency. The agency itself contributed strongly to the presence, and mediation tests confirmed that the agency partially explained stream's impact on presence. Collectively, the findings confirm the conceptual model: stream fosters humanizing pedagogy by enhancing presence directly and by empowering learners psychologically through agency. The structural model reveals that while stream integration exerts a significant direct effect on all three CoI presences,

its influence is substantially channeled through the students' sense of agency (partial mediation). This suggests that pedagogical design alone (stream) is insufficient for high-level online presence; rather, the design must first activate the student's internal psychological capacity to act (agency), which then catalyzes deeper social and cognitive engagement.

5. DISCUSSION

This study provides a significant theoretical contribution by evolving the CoI framework from a descriptive taxonomy of online environments into an explanatory model of pedagogical empowerment. By introducing 'sense of agency' as a mediator, the study provides a psychological explanation for how teaching presence translates into cognitive and social presence. This shifts the focus of CoI research from environmental factors to the internal student-centered mechanisms that sustain an online community, effectively adding a 'conative' (willpower/agency) dimension to the existing framework.

This study set out to examine how stream integration and students' sense of agency contribute to humanizing online pedagogy within the CoI framework. Results integration matrix, presented in Table 5, indicates the key findings, related theories, interpretation, and implications. Collectively, these results provide empirical evidence for an integrated model where design (stream) and psychology (agency) interact to foster humanizing pedagogy.

Table 5. Results integration matrix

	Key finding	Linked theory/framework	Interpretation	Implications
H1	Stream predicts teaching presence ($\beta=.433$, $p<0.001$).	CoI (teaching presence dimension).	Stream tasks require careful instructor scaffolding, making design/facilitation more visible and effective.	Instructors should adopt a guiding role, providing scaffolds and feedback rather than directive control.
H2	Stream predicts cognitive presence ($\beta=0.573$, $p<0.001$).	CoI [2].	Stream tasks promote inquiry, integration, and resolution phases of cognitive presence.	Incorporate authentic, cross-disciplinary problems to deepen reflective and applied learning online.
H3	Stream predicts social presence ($\beta=0.405$, $p<0.001$).	CoI; humanizing pedagogy [8].	Stream encourages collaboration and communication across disciplinary boundaries, fostering interpersonal connections.	Online courses should include stream-based group projects to build belonging and trust.
H4	Stream significantly predicts sense of agency ($\beta=0.497$, $p<0.001$).	Stream pedagogy [13]; agency theory [15]; [17].	Stream's interdisciplinary, choice-rich tasks enhance students' sense of control, authorship, and ownership.	Design stream-based online tasks to embed learner choice, authorship, and interdisciplinary problem-solving.
H5	Sense of agency predicts teaching presence ($\beta=0.299$, $p<0.001$).	Agency and teaching presence interplay.	Students perceive more teaching presence when they co-direct learning with instructors.	Instructors should co-create learning goals with students, enhancing shared responsibility.
H6	Sense of agency predicts cognitive presence ($\beta=0.281$, $p<0.001$).	Agency→CoI [17].	Students who feel in control engage more deeply in critical thinking and knowledge construction.	Provide learners with flexible pathways and opportunities for authorship in digital environments.
H7	Sense of agency predicts social presence ($\beta=0.371$, $p<0.001$). Agency mediates stream→CoI presences (VAF=27–32%).	Agency in collaborative learning. Humanizing pedagogy operationalization.	Ownership encourages authentic expression and relational engagement with peers. Stream influences presence both directly and indirectly through agency, confirming it as a psychological mechanism.	Design reflective and collaborative tasks that foreground learner voice. Online course design should integrate both pedagogical innovation (stream) and psychological empowerment (agency) to humanize digital education.

The findings demonstrate three key outcomes by using PLS-SEM with 107 undergraduate students. First, stream integration directly enhanced students' cognitive, social, and teaching presence. Second, sense of agency significantly predicted all three presences, highlighting its role as a critical psychological driver of meaningful online learning. Third, mediation tests confirmed that agency partially explained the relationship between stream and the CoI presence. The detailed explanation of three key outcomes presented in subsection.

5.1. Stream as a catalyst for online presence

The results show that stream significantly predicts all three presences of the CoI framework. This is consistent with prior studies in school-level contexts demonstrating that interdisciplinary, creative, and authentic tasks promote learner engagement and deep learning [13], [14]. Stream's emphasis on inquiry and

problem-solving supports the phases of cognitive presence, triggering events, exploration, integration, and resolution [2]. The high path coefficient ($\beta=0.573$) suggests that stream tasks stimulate reflective and applied learning in online higher education. This extends CoI research by identifying interdisciplinary design as a key driver of meaning-making processes. Stream tasks involve collaboration across domains, requiring learners to communicate and negotiate meaning. The significant effect on social presence ($\beta=0.405$) aligns with the view that authentic group projects foster interpersonal trust and emotional expression [10]. In the context of humanizing pedagogy, this indicates that interdisciplinarity enhances not just knowledge construction but also relational connection. Stream also predicted teaching presence ($\beta=0.433$), which highlights the central role of instructional scaffolding in complex, interdisciplinary tasks. Instructors are not merely facilitators but designers of learning pathways that balance freedom with guidance. This finding supports earlier claims that instructional design is inseparable from pedagogy [11], underscores the visibility of teaching presence in stream-based courses. Thus, these findings reinforce stream as a catalyst for online presence, bridging technical, cognitive, and social dimensions of learning.

5.2. Sense of agency as psychological mechanism

The second key finding is that students' sense of agency significantly predicts all three CoI presences. This positions the agency as a psychological enabler of meaningful learning experiences. In this sense, these results underscore agency as the psychological bridge that links design to presence. Agency was positively associated with cognitive presence ($\beta=0.281$), and knowledge integration [17]. This extends CoI by highlighting agency as a driver of the cognitive inquiry process. The strong relationship between agency and social presence ($\beta=0.371$) suggests that ownership fosters authentic self-expression and collaboration. This finding is similar to Freire [8], who asserts that empowerment arises from dialogue and co-authorship. In online contexts, for example, as students feel their voices matter, they engage more openly with peers, strengthening the humanizing dimensions of digital interaction. The agency also predicted teaching presence ($\beta=0.299$), which may seem less intuitive. However, this finding reflects that students perceive stronger teaching presence as they are active co-creators in the learning process. Instructors who empower students foster a sense of partnership in course design and facilitation, making teaching presence salient and valued.

5.3. Mediation: agency as partial conduit

The mediation analysis confirmed that agency partially mediated the relationships between stream and the three presences. Variance accounted for (VAF) values of 27–32% indicate that while stream directly predicts presence, its impact is amplified when students perceive agency. This partial mediation is significant for three reasons: i) empirical validates calls to integrate psychological mechanisms into CoI research [4]; ii) positions agency as an operationalization of humanizing pedagogy, providing measurable evidence that empowerment contributes to presence; and iii) suggests a dual pathway: design features matter, but their effectiveness depends on learners' psychological experiences of ownership. This duality resonates with SDT, which argues that environments support autonomy not simply through structure but through enabling authentic choice and authorship [16].

5.4. Implications

While the data were gathered from Malaysian undergraduates, the findings offer broader implications for global online higher education, particularly in post-pandemic contexts where 'digital fatigue' is a universal challenge. The efficacy of stream in fostering agency provides a scalable blueprint for institutions worldwide seeking to move beyond traditional STEM. By prioritizing human-centric, multidisciplinary tasks, universities—regardless of geographic location—can mitigate the transactional distance common in global south and global north digital infrastructures alike.

5.5. Contributions to theory

This study makes four theoretical contributions. First, responding to critiques that CoI is overly descriptive by extending CoI with a sense of agency, incorporating a sense of agency as a mediating construct. The agency provides explanatory power, showing why presences emerge from certain designs. Second, expanding stream into higher education online contexts, as prior stream research has focused on preschool to secondary schools. Thus, this research expands stream's applicability beyond school classrooms to digital university environments. Third, operationalizing humanizing pedagogy by linking design (stream), psychology (agency), and learning outcomes (CoI presences). Thus, the study operationalizes humanizing pedagogy in measurable terms. This contributes to a field where humanization is often discussed conceptually but rarely quantified. Fourth, interdisciplinary integration as the findings bridges technical STEM education with critical pedagogy, creating an integrated model that unites design innovation and humanization in digital education.

5.6. Contributions to practice

The findings also carry significant practical implications for educators and instructional designers. First, online courses should embed choice and opportunities for authorship to strengthen students' agency. For example, offering multiple project pathways or allowing students to select problem contexts can enhance ownership. Second, incorporating stream-based projects can enrich online learning by promoting collaboration across domains, thereby fostering both cognitive and social presence. Third, teaching presence is strengthened when instructors act as designers of complex, authentic tasks and as facilitators of learner autonomy. This requires a shift from directive instruction to co-created learning journeys. Fourth, humanization requires more than emotional support. It requires structural and psychological empowerment. Stream and the agency together provide a systematic approach to achieve this.

5.7. Cultural and contextual considerations

The study was conducted in Malaysia, a context characterized by collectivist cultural values that emphasize interdependence and community [38]. This cultural context may amplify the effects of social presence and collaborative agency. However, the findings may not fully generalize to individualistic cultures where autonomy is prioritized differently. Future research should test the model across diverse cultural settings to strengthen external validity.

5.8. Limitations and future research

The study contributes to theory and practice. However, four limitations were acknowledged. First, the cross-sectional design could limit causal inference. Therefore, it could be better to use longitudinal or experimental designs to provide stronger evidence of directionality. Second, self-administered data may introduce bias. Therefore, future studies could triangulate with learning analytics or discourse analysis. Third, the sample size is limited to four Malaysian universities. Therefore, replication in diverse higher education systems would enhance generalizability. Fourth, agency was central; other constructs, such as emotional presence, belonging, or resilience, could enrich the model. Future research could examine disciplinary variations (STEM vs. humanities), modality differences (synchronous vs. asynchronous), and task types (structured vs. authorship-based). Mixed-methods studies would also help capture the lived experience of agency in stream-based courses.

6. CONCLUSION

This study examines whether students' sense of agency mediates the relationship between stream integration and the three presences of the CoI framework, namely, cognitive, social, and teaching presence in online higher education. The findings demonstrate that stream-based designs directly strengthen cognitive, social, and teaching presence, while also enhancing learners' sense of agency. In turn, the agency partially mediated these relationships, confirming its role as a psychological mechanism through which design features are translated into meaningful learning experiences. This study extends the CoI framework with a construct that bridges design and experience by establishing agency as a mediator. It also operationalizes the notion of humanizing pedagogy by showing that online environments become more authentic and supportive when students are positioned as active agents with control, choice, and authorship in their learning.

The results contribute to theory by advancing an integrated model that links stream, agency, and CoI, and to practice by offering evidence-based strategies for course design. Embedding authentic choice, interdisciplinary tasks, and opportunities for authorship can strengthen learners' sense of presence and foster more human-centered online education. This study highlights a pathway to move beyond functional online delivery towards pedagogy that is both technologically robust and deeply humanizing in an era when digital learning is central to higher education.

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C : Conceptualization

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CONFLICTS OF INTEREST

The author(s) declared no potential conflict of interest with respect to the research authorship and publication of this article.

ETHICAL APPROVAL

Ethical approval for this study was obtained from the UPSI's Research Ethics Committee (Approval Code: 2025-0643-01), ensuring compliance with all applicable ethical standards involving research with human participants. Informed consent was obtained from all participants involved in the study.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author, [CZZ], upon reasonable request. Due to ethical considerations and participant confidentiality, the data are not publicly accessible.

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