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Examining the conceptual alignment of the PEM well-being model through team dialogue in a co-design hackathon

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Well-being is increasingly recognised as integral to learning and educational success, yet its multidimensional and relational nature poses challenges for frameworks and instruments built around predefined constructs. Building on earlier research exploring school-aged students' conceptions of well-being, this study extended the investigation to participants aged over 18 to examine how their co-designed conceptions aligned with the Physical–Environmental–Mental (PEM) model. Data from group discussions during a one-day hackathon involving 21 participants were analysed using deductive and inductive coding. Five of the six constructs identified in the PEM model were reflected in participants' discussions, indicating substantial conceptual alignment. Inductive analysis also identified additional dimensions, including financial and political stability, suggesting the framework may benefit from further development to account for dimensions of well-being salient in adulthood. These findings demonstrate the potential of co-design to evaluate the conceptual coherence of existing well-being frameworks, identify population-specific dimensions and reveal gaps in conceptual relevance. This approach offers a basis for iteratively refining well-being frameworks and instruments across life stages before subsequent empirical testing.

Keywords: co-design, collaboration, dialogue, measurement, well-being

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Introduction/research aims

Student well-being underpins learning, engagement, academic achievement and lifelong success (Organisation for Economic Co-operation and Development [OECD], 2023; United Nations Educational, Scientific and Cultural Organization, 2024; Wong et al., 2024). As the education sector increasingly recognises the importance of the conditions in which students thrive physically, socially and emotionally, multidimensional models of well-being have gained prominence in research and practice (Hossain et al., 2023; Murray et al., 2024; OECD, 2023, 2025a). However, the conceptual adequacy and measurement validity of these frameworks depends on the extent to which researcher-defined constructs reflect individuals' understandings and lived experiences of well-being. This alignment is particularly important because well-being is not necessarily experienced as a set of discrete constructs; instead, it emerges through interactions among individual, relational, social and environmental conditions (Graham et al., 2023; Higgins & Goodall, 2021). The meanings individuals attach

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to these experiences may not align neatly with predefined categories; hence, even theoretically comprehensive frameworks may overlook salient dimensions or operationalise them in ways that inadequately reflect lived experience. Examining the correspondence between established frameworks and participant-generated conceptions can inform assessments of conceptual adequacy and guide the development of measurement instruments more reflective of how people understand well-being.

The need for such alignment is heightened by evolving educational and social contexts, which continually shape the conditions and capabilities associated with well-being. For example, international developments in media and artificial intelligence literacy emphasise critical and responsible engagement, ethical use and informed decision-making (OECD, 2026; OECD & European Commission, 2026). Although these developments concern specific educational competencies, they illustrate the broader importance of ensuring established frameworks remain responsive to changing contexts and the perspectives of those whose experiences they seek to represent. Incorporating participant-generated conceptions into framework evaluation offers a way to examine whether existing models adequately capture these perspectives and to identify dimensions which may warrant further conceptual development or refinement of measurement approaches.

Murray et al.'s (2024) Physical–Environmental–Mental (PEM) model provides a theoretically grounded framework for investigating this alignment. It conceptualises well-being through three dimensions and three cross-cutting factors: Relationships, Voice and Perivallon,[1] and emphasises the interactions between personal, social and environmental influences (Murray et al., 2024). This relational orientation provides a conceptual basis for examining the alignment between an established framework and participant-generated understandings of well-being. However, the extent to which its dimensions and cross-cutting factors reflect participants' own conceptions, including aspects that may extend beyond the model, remains unclear. Furthermore, because the PEM model was developed from school-based literature (Murray et al., 2024), its conceptual relevance beyond school-aged populations has yet to be established. Examining adult conceptions therefore provides an opportunity to investigate the model's applicability beyond its original context while exploring co-design as an approach to evaluating established well-being frameworks before the development or refinement of measurement instruments.

This study addresses these issues by analysing adults' co-designed conceptions of well-being generated through group discussions during a one-day hackathon (see Schulten & Chounta, 2024) involving 21 participants. Using deductive and inductive coding, the analysis examines the extent to which participants' conceptions are represented by the PEM model's dimensions and cross-cutting factors, while identifying additional dimensions which may extend beyond the framework. In doing so, the study evaluates the conceptual correspondence between the PEM model and adult understandings of well-being and considers how co-design can inform the iterative refinement of well-being frameworks across life stages.

The study is guided by the following research question:

To what extent does the PEM model capture adults' co-designed conceptions of well-being, and what additional dimensions, if any, extend beyond the framework?

[1] Perivallon (περιβάλλον), an archaic term meaning "that which surrounds", refers to the physical, social, cultural, spiritual, relational, and contextual conditions that surround, shape, and influence a student's well-being.

Methods

Study design and participants

Data were collected during a one-day co-design hackathon held at a university, involving 21 university-affiliated participants who were recruited through an email invitation to attend the hackathon. All 21 hackathon participants voluntarily agreed to participate in the research. Participants formed five teams: four teams of four and one team of five. Of the 21 participants, 17 were university students and four were university staff. Level of study and discipline were not collected because the event focused on collective co-design rather than subgroup comparison, and student and staff contributions were not analysed separately. Participants comprised 11 females, 8 males, one non-binary/third-gender participant and one who did not specify. Ages ranged from 18-22 (n = 6), 23–25 (n = 3), 26–29 (n = 2) and over 30 (n = 10).

During the 3.5-hour hackathon, each team created a well-being definition with an AI chatbot supporting brainstorming and idea refinement, and participants completed a 20-minute well-being survey. Teams also worked through prompts to define well-being collectively, first identifying the factors representing well-being, then the factors affecting it, and finally integrating these into a written definition. This study analyses these discussions. The chatbot logs, tool artefacts, survey and participants' own well-being fall outside its scope.

Data collection

Five simultaneous audio recorders captured team discussions for about 83 minutes each, with a break in between. Recorders used built-in noise suppression, and teams sat 3 to 4 metres apart. Audio recordings were transcribed using WhisperX (Bain et al., 2023) with the Whisper large-v3-turbo model, which provides word-level timestamps and speaker labels. Transcripts, saved as CSV files, listed each utterance with start and end times, an anonymised speaker ID and the spoken text. Two trained researchers checked all transcripts against the audio to correct transcription errors and speaker attributions. Approximately 5% of words required correction, and all analyses used the verified transcripts. The University's Human Research Ethics Committee approved the study (Protocol 5054), and participants gave written consent.

Qualitative analytical approach

Given that conceptions of well-being emerge through collaborative processes, analysis operated at cohort level, with group discussions treated as complementary sources of evidence. The PEM model (Murray et al., 2024) provided the deductive framework of six a priori constructs, which two researchers interpreted jointly (Table A1). They coded transcripts against these constructs in a spreadsheet with one row per utterance and one binary column per construct and added inductive codes for meanings outside the framework.

The two researchers coded one team's transcript in three iterations covering 10, 30 and 98 rows (approximately 22% of the data). Given the instability of per-construct kappa estimates for infrequently occurring constructs, agreement was assessed using pooled kappa (De Vries et al., 2008), with infrequent codes also reviewed manually. Conflicts were resolved through discussion at each iteration until agreement was substantial (0.61-0.80). Pooled kappa rose from 0.57 to 0.63 and 0.72 across the three iterations. The coders subsequently coded the remaining transcripts independently.

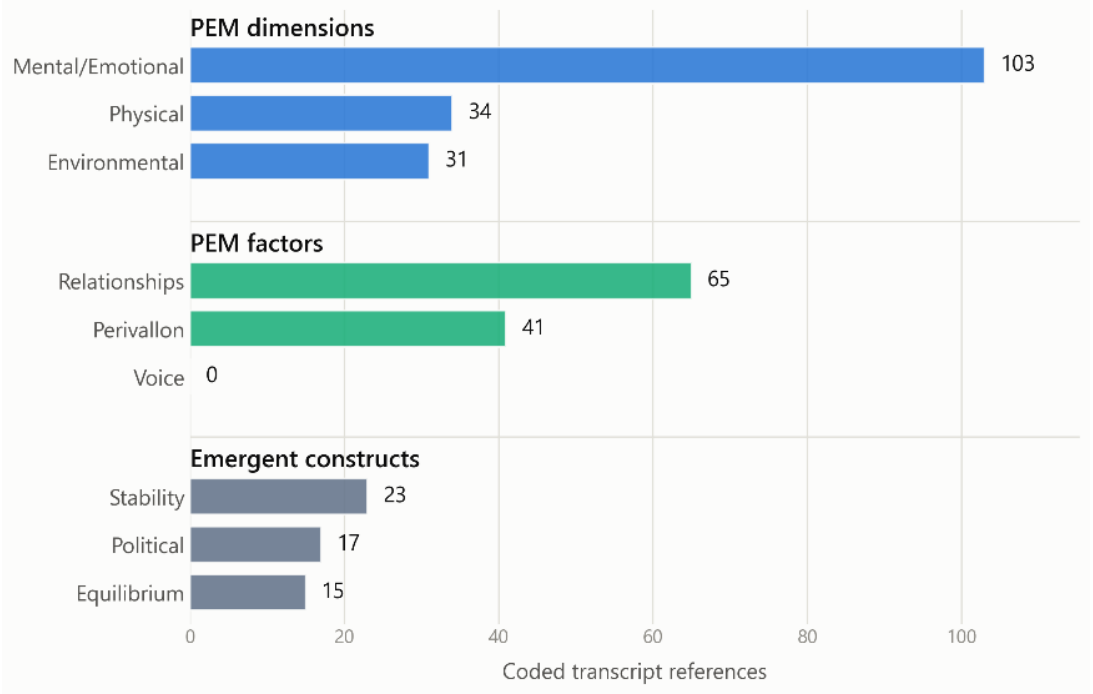
Results

Conceptual alignment between adult conceptions and PEM

Coding identified 329 references, of which 274 mapped to five of the six PEM constructs

identified in Murray et al. (2024) (Figure 1). Mental/Emotional well-being was most frequent (103), followed by Relationships (65), Perivallon (41), Physical (34) and Environmental (31). These five constructs appeared in every group transcript, and Voice appeared in none.

Figure 1: Transcript-derived well-being constructs mapped to and extending the PEM framework (Murray et al., 2024). Five PEM constructs appeared in all five group transcripts; Voice was absent.



Inductive coding identified 55 further references to constructs outside PEM: Equilibrium (15), Stability (23) and Political (17). Equilibrium denotes balance among competing demands, Stability denotes security, including financial security, and Political denotes wider structural and contextual conditions (Table A2).

Table 1 presents illustrative excerpts. Participants described Mental/Emotional well-being as inner states hidden from others and as confidence in self-worth, and Physical well-being as health, energy and exercise, often paired with mental well-being. Environmental references describe safe and restorative surroundings. Relationships centred on support, belonging, and reading others' well-being when people mask how they feel. Perivallon was the broadest construct, spanning surroundings, setting (work versus home), meaning and purpose, and cultural expectations. Among the emergent constructs, participants described Equilibrium as balance and inner peace, Stability as financial and occupational security, and Political well-being relates to how political circumstances, events, elections and government policies influence an individual's sense of well-being, including feelings of security, uncertainty and confidence in the future.

Table 1: Illustrative transcript excerpts by construct.

Constructs	Excerpt
Physical	“You lose your own energy, like you have like the food and whatever like the basic stuff and then you’re just one tier up in the well-being situation.” – Group 1
Mental/Emotional	“When you have enough energy, mental and physical energy to deal with any challenges.” – Group 2
Environmental	“When you’ve been on the computer and you’ve been marking for days, and you walk away from that and you go outside and just get a break from that.” – Group 3
Voice	Not captured in data.
Perivallon	“I guess it also kind of depends on like the context, like well being at work with me, or like, well being at home, well being at home.” – Group 3
Relationships	“If you talk to that toxic people, like toxic person, specifically, they say, oh wait, oh wait, no, this ruin your energy, and then you have to put your tired, and you just don’t want to do it anymore.” – Group 1
Stability	“They don’t have to have a job if they don’t want to, or if they have enough money.” – Group 4
Political	“It’s more political, people who are worried about when he was elected.” – Group 5
Equilibrium	“It’s all about balance isn’t it?” – Group 3

Discussion

This study examined how participants' co-designed conceptions of well-being align with constructs identified in the PEM framework developed by Murray et al. (2024). Five of six constructs appeared in every group, and three further constructs extended the framework. The PEM model was developed from K-12 research (Murray et al., 2024), whereas the present participants were adults, nevertheless the recurrence of five constructs suggests conceptual continuity across developmental and educational contexts. The additional constructs indicate that understandings of well-being may become more differentiated beyond compulsory schooling.

Conceptual alignment with PEM

The transcripts support the conceptual relevance of the PEM model while also revealing complexities in how its constructs are expressed and differentiated. Mental/Emotional well-being was the most prominent construct. This prominence may partly reflect the accessibility of mental and emotional language when articulating well-being (van Agteren & Iasiello, 2020). However, reference frequency indicates discursive prominence rather than construct importance, reflecting both the substance of participants’ conceptions and the language through which they expressed them. Therefore, it should not be interpreted as a direct measure of the relative importance of different dimensions of well-being.

Overlap between constructs further illustrates the interconnected nature of well-being, consistent with PEM’s emphasis on relationships among its dimensions and cross-cutting factors (Murray et al., 2024). For example, overlap between Environmental and Perivallon may indicate that participants understood physical, social, cultural and spiritual conditions as interrelated influences rather than discrete domains. Such overlap suggests participants’ conceptions do not necessarily conform to the boundaries imposed by analytical frameworks. Although categorisation supports systematic analysis, permeable construct boundaries highlight the need to preserve these interrelationships when interpreting well-being and

translating conceptual frameworks into measurement instruments.

Voice was not identified in any group's discussions, despite its designated cross-cutting role in the PEM model. Although this absence warrants consideration, it should not be interpreted as evidence that participants regarded voice as unimportant. Two contextual explanations are plausible. First, the PEM codebook defines Voice in relation to schools, teachers and educational leaders (Appendix, Table A1), potentially limiting its applicability to an adult sample. Second, participants may have enacted voice through the co-design process without explicitly identifying it as a dimension of well-being. Further investigation could therefore examine whether a more context-neutral conceptualisation of Voice better captures participants' understandings across different life stages. The absence of Voice may also be relevant to measurement, since the dimensions included in an instrument shape which aspects of well-being it can capture (OECD, 2013, 2025b).

Extending the framework through student language

Inductive analysis showed participants did more than reproduce PEM categories. Equilibrium, Stability and Political emerged as additional constructs, extending well-being beyond discrete domains to include balance, continuity, security and broader structural conditions. These constructs position well-being as a dynamic, relational condition shaped by individual experience and wider contexts (Appendix, Table A2). The emergence of additional, participant-defined constructs supports co-design as a means of testing established frameworks against participants' own language and extending them (Colvert et al., 2024; Spears et al., 2021), and it agrees with work showing students' accounts span psychological, cognitive, physical, social and contextual dimensions not always represented in researcher-defined categories (White, 2023).

Read against existing theory, the emergent constructs extend the PEM model to differing degrees. Equilibrium echoes balance models of well-being (Dodge et al., 2012) and describes relations among dimensions, which brings it closer to a reframing of PEM's relational orientation. Stability adds material security and autonomy and warrants testing as a distinct dimension. Political locates well-being within wider systems (Bronfenbrenner, 1979; Yamagata-Lynch, 2010) and, given its low frequency and spread, it is best treated as a provisional macro-level extension of Perivallon.

Implications for co-designed well-being measurement

Co-designed frameworks and measures may help translate understandings of well-being into practical approaches for supporting learners. Consistent with the OECD's (2023, 2025a) emphasis on the relationship between well-being, learning, and human flourishing, understanding the conditions enabling learners to thrive is important for educational practice. In higher education, this includes recognising that well-being may be shaped by academic experiences and also by financial situation, relationships, and wider social and political circumstances.

The findings suggest, refining the PEM model through co-design could support more comprehensive approaches to understanding learner well-being. Stability and Political highlight contextual influences which may warrant consideration when identifying learners' needs and developing institutional support, while Equilibrium may help capture how learners manage competing academic and personal demands. These constructs require further investigation before incorporation into measurement instruments, including assessment of their conceptual distinctiveness and relevance across learner populations. Similarly, redefining Voice in more context-neutral terms could help establish its relevance beyond school settings.

Ultimately, the value of extending well-being frameworks lies in improving their capacity to inform practice. Measures grounded in learners' understandings could help educational institutions identify areas requiring support and evaluate whether initiatives address the conditions enabling learning and flourishing. Further empirical testing is needed to establish whether these refinements improve measurement and inform more responsive approaches to learner well-being.

Limitations

The study involved 21 participants in a single one-day co-design hackathon, using a heterogeneous adult sample of university students and staff (level of study and discipline not recorded), differing from the K-12 populations underpinning the original PEM model. This limits conclusions about applicability across student populations and developmental stages. The intensive group format may also have shaped which concepts were articulated; for example, the absence of Voice may reflect the co-design context rather than its absence from students' understandings of well-being. The findings provide evidence of conceptual alignment within this co-design context, rather than validation of the PEM framework. However, they provide a basis for targeted refinement and subsequent empirical testing of the framework and its constructs.

Conclusion

This study demonstrates the value of examining well-being frameworks against participants' own conceptions rather than assuming theoretical comprehensiveness translates directly into adequate measurement. Participant co-design showed substantial conceptual alignment with the PEM framework, with all constructs represented, with the exception of Voice, while also identifying additional constructs to extend its conceptual boundaries. The findings indicate conceptual relevance should be established before measurement adequacy is tested in well-being instrument development. Participatory co-design offers a practical way to identify where established frameworks align with, and diverge from, participants' own conceptualisations, and where theories need refinement. More broadly, the findings support an iterative approach in which participant-generated understandings inform the development and testing of well-being measures that are conceptually grounded, contextually responsive, and appropriately operationalised.

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Disclosure of the use of AI-assisted technologies during writing

During the preparation of this manuscript, the authors used ChatGPT 6.1 Sol (OpenAI) and Consensus to edit the language, check spelling, and identify potentially relevant sources. All sources identified through these tools were subsequently read and verified by the authors. The authors reviewed and take full responsibility for the manuscript's content.

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Appendices

Table A1: Codebook of PEM constructs

Constructs	Description
Physical	Physical well-being refers to a student's overall physical health and ability to function effectively in everyday life.
Mental/Emotional	Mental and emotional well-being refers to a student's ability to understand and manage emotions, cope with stress, maintain positive relationships, and respond effectively to challenges and change.
Environmental	Environmental well-being refers to the valuing of the links between oneself, the spaces we inhabit, and the people we interact with.
Perivallon	Perivallon (περιβάλλον), an ancient Greek term meaning "that which surrounds", refers to the physical, social, cultural, spiritual, relational, and contextual conditions that surround, shape, and influence a student's well-being.
Relationships	Refer to the quality and nature of the connections students have with themselves, their peers, and the staff and adults within their school community.
Voice	Student voice refers to the opportunities students have to express their thoughts, perspectives, experiences, and opinions about their learning and school environment, and to have those views heard and valued. Meaningful student voice requires schools, teachers, and leaders to create supportive environments where students feel respected, listened to, and able to influence decisions which affect their experiences.

Table A2: Codebook of PEM extended constructs

Constructs	Description
Equilibrium	Equilibrium refers to a sense of balance and stability across the different dimensions of an individual's life and well-being. It involves maintaining a balance between competing demands, responsibilities, relationships, activities, and personal needs, while recognising well-being is holistic and influenced by multiple interconnected factors. A sense of equilibrium occurs when individuals are able to manage these different aspects of their lives in ways which support their well-being.
Stability	Stability refers to a sense of security, predictability, and sufficiency in the circumstances of an individual's life, which support their overall well-being. It includes having adequate financial and material resources to meet one's needs, as well as the freedom and autonomy to make choices about work, responsibilities, and how one spends their time. A sense of stability occurs when individuals feel sufficiently secure in their circumstances, they are able to focus on their well-being and make choices based on their needs, values, and preferences rather than financial necessity.
Political	Political refers to the influence of political circumstances, events, policies, and leadership on an individual's sense of well-being. It recognises that well-being is shaped by personal and social experiences, and by the wider political environment in which individuals live. Political concerns may affect well-being through feelings of uncertainty, anxiety, security, belonging, or confidence in the future, particularly when political changes or events are perceived to have consequences for individuals, their communities, or society more broadly.