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Integrating Philosophical Inquiry into an Advanced Creative Problem Solving Course Focused on Metaverse-Based Micro Entrepreneurship

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Abstract: Developing entrepreneurial projects within a single semester remains challenging for university students. This study examined an 18-week Advanced Creative Problem Solving course that integrated philosophical inquiry with metaverse micro entrepreneurship to help students address complex problems and develop project proposals and prototypes. A single-group pretest–posttest design involved 44 students enrolled across two semesters in the 2022-2023 academic year. Data comprised UCAN competency assessments, an adapted flow questionnaire, qualitative student feedback, and recorded group discussions. Exploratory paired-samples t tests indicated increases in self-reported innovation, communication, and information technology application at the unadjusted .05 significance level, but not in problem solving ($p = .101$). Students reporting flow emphasized clear goals and challenging tasks, whereas difficulty concentrating was associated with its absence. Students generally reported limited perceived control. Lag sequential analysis identified transitions from ideation to classification ($z = 10.184$), classification to connection ($z = 19.509$), and connection to solution generation ($z = 3.826$). Repeated solution-generation codes were also prominent ($z = 16.630$), although these may reflect sustained activity rather than the generation of distinct new projects. One student group won first prize in a departmental project competition for its metaverse micro entrepreneurship project. The findings illustrate the implementation of philosophical inquiry within a technology-focused entrepreneurship course and identify discussion patterns for further investigation. The absence of a comparison group, selective discussion sampling, and incomplete measurement information limit causal interpretation and generalizability.

Keywords: philosophical inquiry; creative problem solving; metaverse; micro entrepreneurship; lag sequential analysis; flow

Introduction

Emerging technologies can stimulate students' interest in entrepreneurship without giving them a clear route from an initial idea to a workable project. This difficulty was evident in earlier offerings of an Advanced Creative Problem Solving course. Students were curious about digital twins, non-fungible tokens, and virtual environments, but often did not know how to develop these interests into entrepreneurial proposals. Their questions extended beyond technical implementation to social acceptance, economic feasibility, privacy, security, and ethics. Addressing these questions required sustained inquiry into the problem and its assumptions.

The course developed from earlier teaching that combined project-based learning, computational thinking, cloud services, extended reality, and artificial intelligence of things. Design thinking had helped students attend to users' needs, and students had participated successfully in creativity and entrepreneurship competitions. Nevertheless, the instructor observed that students often sought a quick, correct answer instead of examining alternative interpretations. Brainstorming and other divergent-thinking activities generated ideas, but deeper consideration of their premises, implications, and feasibility remained a teaching challenge.

This study introduced philosophical inquiry into a course organized around metaverse micro entrepreneurship. Philosophical inquiry was used in a practical instructional sense: articulating a problem, examining assumptions, considering alternative perspectives, and providing reasons for a proposed solution. It complemented creative idea generation through three change questions drawn from the Theory of Constraints (TOC): what to change, what to change to, and how to cause the change (Goldratt, 1990; Mabin, 1999). The entrepreneurial goal was to develop small-scale digital products or services that students could explore within one semester. Course outcomes therefore concerned proposals and prototypes rather than verified business formation or commercial performance.

The metaverse provided a shared context for these activities. Its combination of virtual environments, digital identities, content creation, and possible economic exchanges offered problems that could be approached from technological and humanistic perspectives (Lee et al., 2021). Educational accounts of the metaverse have also emphasized the relationship between technological capabilities and learning design (Zhang et al., 2022). A subsequent systematic review situated educational metaverse research within a longer history of virtual learning

environments and examined its applications, technical solutions, and implementation challenges (Feng et al., 2024). These accounts support examining what learners actually do within a particular instructional design rather than treating the technology label as evidence of educational effectiveness.

The present study brings together three forms of evidence: changes in students' self-reported employability competencies, the sequential organization of selected group discussions, and students' descriptions of their learning experiences. The instructional objectives were to help students apply creative and philosophical thinking systematically, integrate knowledge across fields, recognize emerging technological possibilities, examine flow during inquiry, develop metaverse micro entrepreneurship projects, and strengthen innovation and problem solving. These objectives were consolidated into three research questions aligned with the available evidence.

RQ1. What changes occurred in students' self-reported general employability competencies after the course?

RQ2. What behavioral sequences characterized the selected philosophical-inquiry discussions about metaverse micro entrepreneurship?

RQ3. What projects and learning experiences were documented, particularly in relation to flow and perceived control?

Conceptual Background

Metaverse Technologies and Entrepreneurial Learning

The metaverse is treated here as an organizing concept for digitally mediated spaces, identities, activities, and exchanges. Lee et al. (2021) described enabling technologies that include extended reality, human–computer interaction, artificial intelligence, blockchain, computer vision, the Internet of Things and robotics, edge and cloud computing, and mobile networks. The course introduced these technologies as resources for inquiry and project development. It did not implement a single persistent, interoperable virtual world. Students instead encountered a combination of virtual environments, avatar-based classrooms, digital content tools, and hands-on activities.

Extended reality encompasses augmented reality, virtual reality, and mixed reality. These approaches differ in how digital content relates to a user's physical surroundings and in the interaction they support. The distinction was useful pedagogically because a panoramic image, an interactive virtual environment, and a spatially registered digital object offer different possibilities for action. Accordingly, producing a 360-degree scene was an accessible entry activity, whereas building an interactive application required additional design and technical work.

Previous research provides examples of how immersive environments can support specific educational tasks. These include virtual visits to reconstructed heritage sites (Kersten et al., 2017), an ophthalmoscopy trainer (Wilson et al., 2017), learning fractions through musical activities (Ke et al., 2017), and graphic design instruction (Lou, 2017). A review by Kavanagh et al. (2017) examined the use of virtual reality in education. Research on oral presentations also illustrates how virtual environments can provide practice and feedback for communication tasks (van Ginkel et al., 2019). These examples informed the range of project opportunities introduced in the course; they do not establish that all virtual environments produce the same learning outcomes.

Computational thinking was another relevant application. Sims et al. (2021) investigated Logibot, a virtual reality approach to computational-thinking activities. The present course similarly used block-based programming and game tasks to make computational processes accessible to students with different technical backgrounds. Avatars, projection demonstrations, and live streaming introduced ways of representing a user and communicating through digital content. Digital twins provided a further example of linking physical processes with digital representations. Reviews of digital twins in production systems and work on their integration in healthcare helped situate this concept beyond the narrower idea of a visual avatar (Croatti et al., 2020; Negri et al., 2017).

Micro entrepreneurship was defined for this course as exploring a small-scale digital product or service with limited initial resources. Possibilities included digital artwork, music, video, virtual experiences, and educational applications. Digital assets, blockchain, and NFTs were discussed as possible elements of an entrepreneurial model. They were not assumed to be necessary features of every project or proof of its commercial viability. Mukhoryanova et al. (2021) examined microenterprise sustainability in the digital economy, while Situmorang et al. (2021) developed mobile augmented reality materials to introduce small and medium-sized enterprises to university students. Together, these studies provided a rationale for connecting digital technologies with entrepreneurial learning while retaining attention to users, context, and implementation.

Theoretical Foundation of Philosophical Inquiry

The philosophical-inquiry activities were structured around three fundamental questions derived from Goldratt's (1990) TOC Thinking Processes: (1) *What to change?*, (2) *What to change to?*, and (3) *How to cause the change?*Mabin (1999) explains how these questions organize problem identification, solution development, and implementation. In this study, the *333 principle* is used as a pedagogical shorthand for this three-question framework. Its theoretical basis lies in TOC; the label identifies the course's instructional adaptation rather than a separately established philosophical theory.

The Thinking Processes connect the diagnosis of current difficulties with reasoning about possible interventions and the conditions required for change. Mabin (1999) describes the use of causal and necessary-condition reasoning to examine problems, evaluate solutions, and identify barriers to implementation. Kim et al. (2008) review the evolution and applications of these processes, including their use alongside other problem-solving approaches. In a subsequent synthesis, Mabin and Cavana (2024) map the three questions to identifying a core problem, constructing and testing a solution, and developing an implementation plan. This later account provides a conceptual basis for interpreting the course, which was implemented in the 2022-2023 academic year.

In this course, philosophical inquiry involved examining the meaning of a problem, questioning assumptions, evaluating reasons, and changing perspectives. Creative problem solving supplied ways to generate and organize possibilities; philosophical inquiry encouraged students to consider why those possibilities were appropriate and what consequences they might have. Students were encouraged to distinguish factual claims from opinions and to revisit their own reasoning instead of treating the first plausible idea as a final answer.

Instruction also drew on examples of practical philosophical thinking, including a reading and an instructor-produced explanatory video based on Yoshida (2021). Activities emphasized stating and defining the problem, changing perspectives, generating ideas, classifying them, and connecting them into a possible solution. The three-question framework provided a recurring scaffold for connecting philosophical reflection with creative problem solving and experiential entrepreneurial practice. The framework is described here as a set of discussion prompts; the study does not evaluate implementation of the complete TOC toolkit.

The routine was intended to make students' reasoning visible to their peers. For example, a proposal for a virtual music rehearsal room could prompt questions about likely users, the circumstances in which they would rent it, the need for teachers or equipment, and the distinction between entertainment and instruction. Such questions connected technological possibilities with a proposed use. The coding framework described below operationalized observable discussion behaviors associated with this process; it did not directly measure argument quality, the validity of a conclusion, or mastery of philosophy.

Flow and perceived control

Flow describes an experience of deep involvement in an activity (Csikszentmihalyi, 1990). The course was designed to provide a coherent project goal and tasks that could challenge students while allowing them to use developing skills. Kiili (2006) examined flow in experiential gaming and identified relevant antecedents, including a match between challenge and skill, clear goals, feedback, and perceived control. This work informed the adaptation of a questionnaire for philosophical-inquiry discussions.

Flow and perceived control were treated as related but distinguishable aspects of experience. Students could find an open-ended discussion absorbing while remaining uncertain about how to direct it or implement the resulting project. The study therefore considered both students' descriptions of flow and their accounts of control. The questionnaire items are reproduced in Appendix A to make the adaptation transparent.

Sequential analysis of collaborative discussion

Lag sequential analysis examines whether particular behaviors follow other behaviors more often than expected under a specified baseline model (Bakeman & Gottman, 1997). It can reveal the local organization of an interaction that is not apparent from code frequencies alone. Hou et al. (2008) applied sequential analysis to problem-solving discussions, and Ozturk et al. (2014) examined its use in learning analytics.

Menning et al. (2016) introduced the Topic Markup Scheme and Knowledge Handling Notation as complementary approaches to analyzing design conversations. The present study drew on these approaches to develop a course-specific framework for visible discussion behaviors. The analysis focused on adjacent coded observations. It was intended to describe recurring transitions within the selected discussions, not to establish that a particular sequence caused a successful project.

Methods

Research design and participants

The study used a pre-experimental, single-group pretest-posttest design supplemented by classroom observations, student feedback, project documentation, and content and sequential analyses of recorded discussions. Participants were drawn from two offerings of the general education course Advanced Creative Problem Solving in the first and second semesters of the 2022-2023 academic year in Taiwan. Each offering lasted 18 weeks and carried two credits. Forty-four students provided matched pretest and posttest responses on the UCAN general employability competency assessment. No comparison group was included.

The course was designed for students with varied disciplinary backgrounds. An introductory avatar activity helped students introduce themselves and form heterogeneous groups, with six students per group as the intended arrangement. Students then worked collaboratively on metaverse micro entrepreneurship proposals and projects. The quantitative analysis pooled the matched responses across the two offerings. Discussion analysis focused on projects regarded as stronger course outcomes, making it an examination of selected cases rather than a representative sample of all classroom interaction.

Course design and learning activities

The course combined face-to-face instruction, guest talks, technological demonstrations, collaborative inquiry, and project work. Its learning goals included integrating existing knowledge with new ideas, understanding possible metaverse applications, evaluating alternative solutions, communicating reasoning, and working collaboratively. Technical topics provided material for discussion rather than an expectation that every student would master every technology. Table 1 summarizes the 18-week curriculum.

Table 1: Overview of the 18-week curriculum

Week	Focus	Activities and intended learning opportunities
1	Course orientation and identity	Film examples, avatar design and peer introductions; heterogeneous team formation; introductory entrepreneurial thinking.
2	Understanding the metaverse	Explore a virtual environment and generate a panoramic scene using Skybox AI.
3	Enabling technologies	Introduce XR, blockchain, digital assets, and digital twins; use written peer discussion to examine possibilities and questions.
4	Creating an avatar	Design a personal representation and explore how a two-dimensional drawing can be represented in a virtual environment.
5	Avatar projection	Construct a projection box using cardboard or 3D printing and combine projected effects with physical models.
6	Digital twins	Discuss simulation and digital representations through transport, agriculture, and aquaculture examples.
7	Microentrepreneurship	Examine small-scale entrepreneurial models and develop initial group proposals.
8	Virtual economies	Discuss infrastructure, work, entertainment, finance, retail, education, digital assets, and possible exchange models.
9	Metaverse applications	Explore work, leisure, and learning scenarios; use a five-in-a-row idea activity to develop project questions.
10	Midterm integration	Present proposals; identify the expertise and technologies needed; review recorded group discussions.
11	Education and language learning	Explore virtual classrooms and game-like learning; discuss School 42 and N High School as contrasting educational examples.
12	Computational thinking	Use game tasks and block-based programming to make computational processes visible.
13	NFTs and digital works	Discuss digital artwork, distinct digital assets, and intellectual property questions.

Week	Focus	Activities and intended learning opportunities
14	Avatar livestreaming	Explore communication through live human presenters and virtual representations.
15	Virtual leisure and entertainment	Examine concerts, events, and entertainment services as possible application contexts.
16	Philosophical inquiry	Apply the three TOC-derived questions to examine problems and assumptions, consider alternatives, and plan how to refine and implement microentrepreneurship proposals.
17	Culture and responsible design	Discuss animation-related culture, social acceptance, security, and privacy.
18	Final exhibition	Present and demonstrate group microentrepreneurship projects in a metaverse-oriented format.

The schedule describes the course design. Philosophical inquiry and group discussion were also integrated throughout the semester. The use of individual tools may have differed between the two offerings.

Philosophical-inquiry discussions used the three TOC-derived questions as a recurring guide to project development (Goldratt, 1990; Mabin, 1999). When considering *what to change*, students were encouraged to identify the problem and examine its underlying assumptions. *What to change to*prompted consideration of alternative perspectives and possible solutions, whereas *how to cause the change* directed attention to practical strategies for implementing entrepreneurial ideas. The questions supported reflection throughout the metaverse-based micro entrepreneurship projects and could be revisited as proposals developed. They structured inquiry without prescribing a fixed sequence of coded discussion behaviors.

Several activities supported participation. In the first week, students colored and named an avatar, wrote a statement representing it, introduced themselves in pairs, introduced their partner to others, and indicated their preferred designs. This activity linked identity and digital creation with team formation. A written-discussion activity subsequently asked students to add ideas and questions to large sheets of paper and respond to their classmates' contributions. Another activity used a 100-cell board and sticky notes in a five-in-a-row format, encouraging groups to generate ideas while considering the contributions already on the board.

Students used Skybox AI to generate panoramic scenes and experienced an avatar-based classroom through UNIVERSE by ViewSonic. In the virtual classroom, students could move through the space, interact through avatars, and view the instructor's presentation. Duolingo was demonstrated as an example of game-like language learning, after which groups explored different languages. These activities helped one group formulate a virtual Vietnamese supermarket in which users could move through the setting and learn vocabulary associated with objects. The course also included avatar projection, digital-twin cases, block-based programming, digital assets, and virtual entertainment. Figures 1 and 2 document selected virtual environments and classroom experiences.

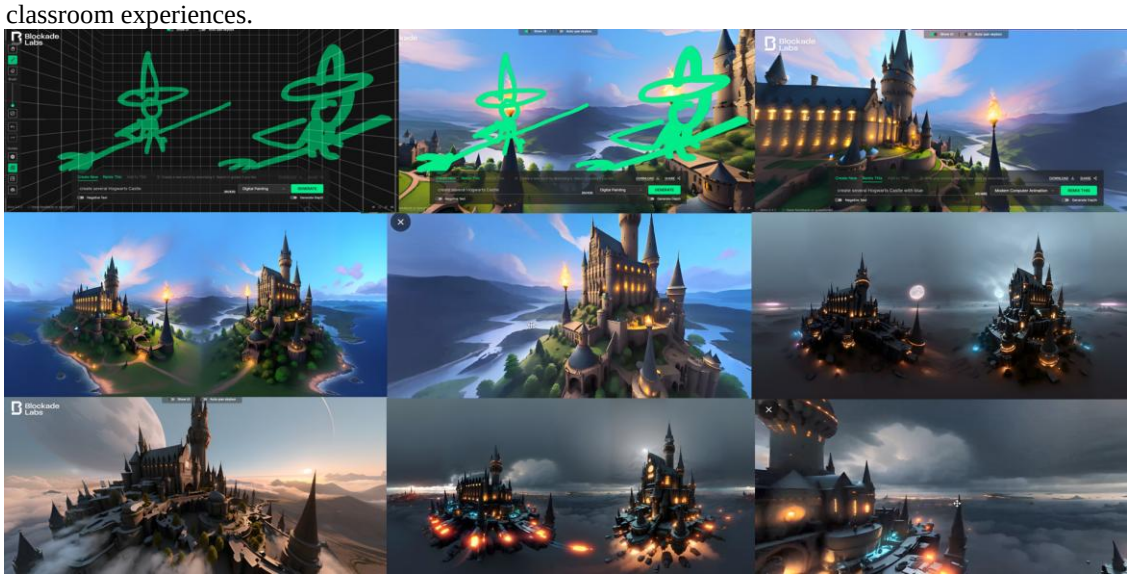


Figure 1a: Examples of generated panoramic scenes and visual variations created with Skybox AI.



Figure 1b: Further examples of panoramic scenes used to explore possible virtual environments.



Figure 2: Avatar-based classroom activities in UNIVERSE by ViewSonic. Students could move through the virtual classroom and view instructional content.

On November 19, 2022, students also conducted an English learning activity at an elementary school in Taoyuan, Taiwan. This activity provided a physical setting in which students could try an educational design. It is reported as part of the course context; learning outcomes for the elementary-school participants were not evaluated in this study. Additional instructional documentation appears in Appendix C.

Assessment combined formative participation and summative project work. The grading allocation was weekly thematic discussions, 15%; classroom interaction, 15%; learning records, 5%; a midterm oral report, 10%; a midterm written report, 10%; a final oral report, 10%; a final written report, 10%; the final metaverse-format exhibition, 20%; and participation in relevant creativity, innovation, or entrepreneurship competitions, 5%. The final project was a capstone opportunity to integrate the semester's learning.

Measures and Data Sources

General employability competencies

Students completed the general employability assessment on Taiwan's Ministry of Education UCAN platform at the beginning and end of the course. Four domains were analyzed with paired-samples t tests: problem solving, innovation, communication, and information technology application. The available summary also included an overall score and correlations among eight UCAN domains. The other domains were continuous learning, interpersonal interaction, teamwork, and work responsibility and discipline. UCAN responses were treated as self-reported competencies rather than direct performance tests.

Discussion records and coding

Group discussions were video recorded. Two coders with relevant backgrounds reviewed the recordings, assigned behavioral codes, and discussed disagreements to reach a consensus. The reported interrater agreement was $\kappa = .87$. More than seven hours of selected face-to-face discussions were sampled at five-second intervals,

producing 5,735 coded observations. The final framework comprised nine categories: ideation, classification, connection, problem statement, problem definition, perspective change, departure from the focal topic, solution generation, and other behavior. Table 2 provides the operational definitions and translated examples.

Table 2: Discussion coding framework and translated examples

Code	Category	Operational definition	Illustrative example
I	Ideation	Propose possible ideas.	We could start with entertainment, including television, films, and music.
Cla	Classification	Group ideas according to their characteristics.	Bands belong to the music category, and music tutoring also belongs to that category.
Con	Connection	Identify relationships among categorized ideas.	Both involve music, so we could bring bands and teachers together.
S	Problem statement	Express the problem or proposal clearly.	I think we could create a metaverse rehearsal room, especially for expensive equipment such as drum kits.
D	Problem definition	Specify the meaning or scope of the problem or idea.	The rehearsal room could offer instrument rental and lessons from teachers.
CP	Perspective change	Examine the problem from another viewpoint.	Who would be most likely to rent a rehearsal room, and under what circumstances?
Esc	Topic departure	Move beyond the focal topic or frame to another topic.	How would an instrument be tuned if it went out of tune?
Gen	Solution generation	Formulate a microentrepreneurship solution.	Create a rentable rehearsal room in the metaverse where teachers can also give lessons.
O	Other behavior	Behavior not covered by the substantive categories.	The film yesterday was really good!

Examples translate those supplied with the course coding framework. They illustrate code meanings and are not presented as independently verified verbatim transcripts. S = problem statement; D = problem definition.

The framework retained the original code labels to preserve consistency between the frequency tables, residual matrix, and transition diagram. S denotes stating the problem, whereas D denotes defining the problem. Esc denotes a departure from the focal discussion that may involve a related topic; O captures behavior outside the substantive categories. This distinction is descriptive and does not by itself classify a departure as productive or unproductive.

Flow and student feedback

A questionnaire adapted from Kiili (2006) addressed experiences during philosophical-inquiry discussions. It contained 19 statements, a direct question about having experienced flow after reading a description, and two open-ended questions about factors that facilitated or inhibited flow. The items addressed challenge, goals, self-assessment, concentration, control, self-consciousness, time perception, and enjoyment. No validated composite flow score is reported here. The results concern the available descriptive account of students' responses.

Additional evidence came from student projects, oral and written reports, instructor observations, and routine course evaluations. Student comments were translated from Chinese into English. The comments presented below illustrate the reported experiences and were not analyzed as an independently validated qualitative dataset. Competition recognition was treated as contextual evidence of project accomplishment, not as a standardized outcome measure.

Data analysis

Pretest and posttest means and standard deviations were summarized for the four focal UCAN domains and the reported overall score. Paired-samples t tests compared the two measurements. To make the reported statistics interpretable, two-sided p values were calculated from the tabulated t values assuming 44 matched

observations and 43 degrees of freedom. Cohen's d_z was calculated as the magnitude of the paired t statistic divided by the square root of 44, with positive values indicating an increase from pretest to posttest. Tests are reported as exploratory and unadjusted for multiple comparisons. Correlation matrices are presented descriptively in Appendix B.

For discussion data, code frequencies and percentages described the distribution of observed behaviors. Lag-one transitions were examined using the reported adjusted residual matrix. Positive residuals greater than 1.96 were used to identify transitions occurring more often than expected under the analysis baseline. Negative residuals in the full matrix indicate transitions occurring less often than expected. The threshold was applied to individual cells without a reported multiplicity adjustment. The transition results are therefore exploratory, especially for values close to the threshold.

The analysis retained self-transitions, such as I to I and Gen to Gen. Because the records were sampled at five-second intervals, a self-transition can reflect the continuation of one activity across adjacent intervals. It does not necessarily indicate the initiation of a new idea or a distinct new solution. Likewise, several significant adjacent transitions do not establish that a complete multistep pathway occurred as a single sequence.

Results

Changes in self-reported competencies

All four focal UCAN domain means were higher at posttest than at pretest (Table 3). Innovation increased from 3.617 to 3.883, communication from 3.877 to 4.078, and information technology application from 3.815 to 4.099. Based on the reported t statistics, these differences met the unadjusted .05 significance threshold. The corresponding within-person standardized changes were d_z = 0.400, 0.409, and 0.380, respectively.

Problem solving increased only slightly, from 3.891 to 3.920. Its reported t value of -1.676 corresponds to a two-sided p value of approximately .101 with 43 degrees of freedom. Thus, the available statistics do not support a statistically significant improvement in this domain. The reported overall score increased from 3.800 to 3.995, but this aggregate is not used to infer improvement in every individual competency.

Table 3: UCAN pretest and posttest scores and paired comparisons

Competency	Pretest M (SD)	Posttest M (SD)	Mean change	t	p	d_z
Problem solving	3.891 (0.664)	3.920 (0.754)	0.029	-1.676	0.1010	0.253
Innovation	3.617 (0.624)	3.883 (0.718)	0.266	-2.656	0.0110	0.400
Communication	3.877 (0.590)	4.078 (0.574)	0.201	-2.712	0.0096	0.409
Information technology application	3.815 (0.705)	4.099 (0.632)	0.284	-2.519	0.0156	0.380
Overall score	3.800 (0.540)	3.995 (0.566)	0.195	-2.523	0.0154	0.380

N = 44; assumed df = 43. Mean change = posttest minus pretest. The negative t signs reflect the reported pretest-minus-posttest contrast. Two-sided p values and positive Cohen's d_z values were calculated from the reported t statistics and N, not from participant-level data. Tests are unadjusted for multiple comparisons. The overall score is retained but is not the unweighted mean of the four displayed domain means.

The pretest correlation matrix showed positive associations between problem solving and communication (r = .823), innovation (r = .784), continuous learning (r = .748), and information technology application (r = .707). At posttest, relatively strong correlations included problem solving with innovation (r = .828), interpersonal interaction with work responsibility and discipline (r = .836), and innovation with work responsibility and discipline (r = .805). These descriptive associations do not demonstrate that one competency produced another or that the correlations changed significantly over time. The complete matrices are retained in Appendix B.

Distribution of discussion behaviors

The nine coding categories accounted for 5,735 observations (Table 4). Departures from the focal topic were the most frequent category (Esc; 974 observations, 17.0%), followed by other behavior (O; 776, 13.5%) and problem definition (D; 773, 13.5%). Among the substantive inquiry categories, problem definition and problem statement (S; 685, 11.9%) were particularly frequent. Perspective change accounted for 672 observations (11.7%). Solution generation was the least frequent category (Gen; 195, 3.4%).

These frequencies indicate that much of the observed interaction concerned articulating, defining, and reconsidering the problem. They also show that a substantial part of the coded discussion involved topic departures or other behavior. Because the codes describe time-sampled observations, their frequencies cannot be interpreted as counts of independent ideas, completed solutions, or students.

Table 4: Distribution of time-sampled discussion codes

Code	Category	Frequency	Percentage
I	Ideation	510	8.9%
Cla	Classification	625	10.9%
Con	Connection	525	9.2%
S	Problem statement	685	11.9%
D	Problem definition	773	13.5%
CP	Perspective change	672	11.7%
Esc	Topic departure	974	17.0%
Gen	Solution generation	195	3.4%
O	Other behavior	776	13.5%
	Total	5,735	100.0%

Percentages use all 5,735 observations as the denominator. Individual rounded percentages sum to 100.0%. Frequencies count sampled observations, not independent events or participants.

Sequential patterns in philosophical inquiry

The adjusted residual matrix identified 22 positive transitions above the 1.96 threshold (Table 5). A prominent set of transitions connected ideation with classification (I to Cla, $z = 10.184$), classification with connection (Cla to Con, $z = 19.509$), and connection with solution generation (Con to Gen, $z = 3.826$). Reverse transitions from classification to ideation (Cla to I, $z = 1.996$) and from connection to classification (Con to Cla, $z = 8.195$) indicated that the discussion did not follow a uniformly linear progression. Connection also preceded problem definition more often than expected (Con to D, $z = 2.175$).

Problem statement and problem definition were reciprocally related (S to D, $z = 11.786$; D to S, $z = 8.543$). Problem definition sometimes led to perspective change (D to CP, $z = 2.093$). Perspective change was associated with topic departure in both directions (CP to Esc, $z = 5.684$; Esc to CP, $z = 7.528$). The transitions between topic departure and other behavior were also pronounced (Esc to O, $z = 17.393$; O to Esc, $z = 17.312$).

Self-transitions were positive for all nine categories. Particularly large residuals were observed for ideation (I to I, $z = 19.987$), solution generation (Gen to Gen, $z = 16.630$), and problem definition (D to D, $z = 15.941$). These results indicate persistence of the corresponding coded activity. They are consistent with sustained work within a discussion phase, although the five-second sampling procedure prevents an inference that each repeated Gen code represented another distinct solution. The full residual matrix is provided in Table 6, and Figure 4 displays the transition network.

Table 5: Positive lag-one transitions above the residual threshold

Preceding code	Subsequent code and adjusted residual
I	I (19.987); Cla (10.184)
Cla	I (1.996); Cla (9.910); Con (19.509)
Con	Cla (8.195); Con (8.245); D (2.175); Gen (3.826)
S	S (12.221); D (11.786)
D	S (8.543); D (15.941); CP (2.093)
CP	CP (13.051); Esc (5.684)
Esc	CP (7.528); Esc (7.001); O (17.393)

Preceding code	Subsequent code and adjusted residual
Gen	Gen (16.630)
O	Esc (17.312); O (14.443)

All 22 cells with z > 1.96 are shown, including nine self-transitions. Values are unadjusted cellwise residuals. Near-threshold transitions should be interpreted cautiously. Rows identify the preceding code and entries identify the subsequent code.

Table 6: Full adjusted residual matrix for discussion transitions

From / to	I	Cla	Con	S	D	CP	Esc	Gen	O
I	**19.987**	**10.184**	-1.399	-1.134	-5.264	-2.851	-8.348	-2.648	-5.156
Cla	**1.996**	**9.910**	**19.509**	-4.529	-5.740	-7.279	-3.280	-3.333	-4.903
Con	-1.560	**8.195**	**8.245**	0.463	**2.175**	-6.481	-6.110	**3.826**	-4.959
S	-3.269	0.058	-3.620	**12.221**	**11.786**	-2.427	-5.977	-1.407	-8.048
D	-5.128	-2.265	-4.126	**8.543**	**15.941**	**2.093**	-9.289	1.432	-6.739
CP	0.899	-7.015	-6.481	-0.415	1.251	**13.051**	**5.684**	-2.232	-7.074
Esc	-7.243	-7.354	-4.046	-5.569	-10.226	**7.528**	**7.001**	-0.994	**17.393**
Gen	-1.624	-1.930	-2.489	-1.639	-0.701	1.552	-0.600	**16.630**	0.769
O	-0.952	-6.514	-4.156	-8.059	-8.886	-5.034	**17.312**	-3.704	**14.443**

Rows = preceding code; columns = subsequent code. Bold values exceed 1.96 and indicate positive transitions under the reported analysis. Negative residuals indicate less frequent transitions than expected. The matrix is reproduced without re-estimating transition counts or expected frequencies.

Student projects and learning experiences

The course produced projects involving Vietnamese language learning in a virtual supermarket, a virtual moving maze, automated metaverse content generation, virtual shooting practice, and a virtual drumming experience. These projects demonstrated how students connected technological examples with possible uses in education and entertainment. One group completed a physical artifact, and a group received first prize in a departmental project competition. The available evidence does not establish whether these descriptions refer to the same group. Representative project images are shown in Figure 3.

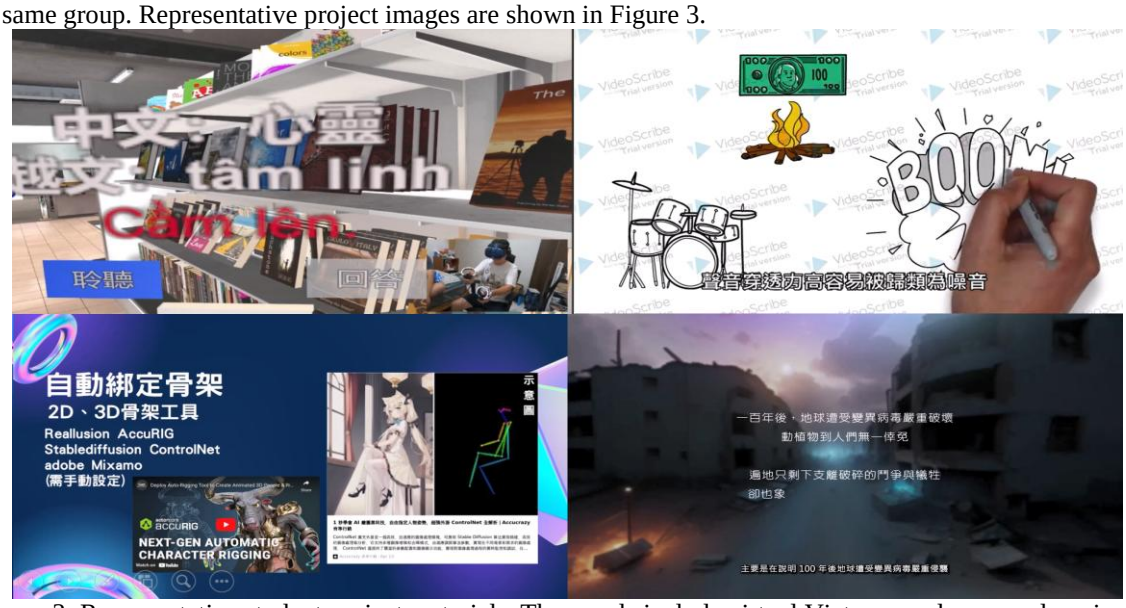


Figure 3: Representative student project materials. The panels include virtual Vietnamese language learning, a drumming concept, automated digital-character or environment content, and a virtual game setting. Embedded text belongs to the original project interfaces.

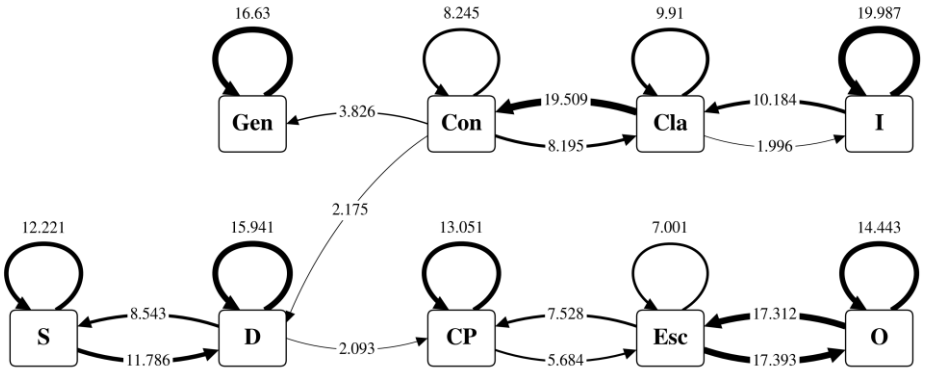


Figure 4: Positive lag-one transition network from the original analysis. Labels are adjusted residuals; code definitions appear in Table 2. The classification self-transition is z = 9.910. All arrows represent adjacent coded observations rather than causal links.

Fifteen students described experiencing flow during philosophical-inquiry activities. They attributed these experiences mainly to clear goals and challenging tasks. Difficulty concentrating was reported as an obstacle when flow did not occur. The qualitative account also indicated that students generally did not perceive a sense of control. The number of respondents to the flow questions and the scoring procedure were not established, so these descriptions are not interpreted as a prevalence estimate or a measured improvement in a flow scale.

The comments reproduced in the course account were positive and described an approachable classroom atmosphere, stimulation of ideas, meaningful discussion, and appreciation of the instructor's effort. These evaluations provide information about students' perceptions, but their scale anchors, response counts, and relation to the research sample were not specified.

Several comments addressed learning more directly. One student explained, “We needed to integrate what we had learned during the semester and consider issues such as personal data security and realism so that our proposal would be more complete.” Another observed, “Although the course focused on the metaverse, what I learned could be applied in many other areas.” A further comment described learning from other groups' presentations and considering whether an original project idea could be implemented. One student reported continuing to use Duolingo to study Japanese after the course and attributed this continued activity to increased motivation for self-directed learning. These examples illustrate perceived integration and transfer; they do not constitute follow-up evidence for the full cohort.

Discussion

Connecting technological exploration with inquiry

The course illustrates a practical way to organize a broad set of emerging technologies around a shared problem-solving purpose. Students encountered virtual spaces, avatars, digital assets, and computational activities, then considered what kinds of products or services those resources could support. Philosophical inquiry provided prompts for examining the problem and its assumptions. The contribution lies in documenting this combination and its observable discussion processes, rather than demonstrating the effectiveness of a particular platform. The three TOC-derived questions provide a rationale for linking scrutiny of a problem with evaluation of alternatives and implementation planning (Mabin, 1999; Mabin & Cavana, 2024).

The significant increases in innovation, communication, and information technology application were consistent with the activities emphasized in the course. Students repeatedly proposed ideas, explained them to peers, and used digital tools. These alignments offer plausible interpretations of the observed changes, but the design cannot separate the contributions of philosophical inquiry, project work, instructor support, peer interaction, or the novelty of the technology. The findings concern self-reported change during participation in the combined course.

The nonsignificant change in problem solving is equally relevant. An instructional aim should not be treated as an achieved outcome when the reported test does not support it. More demanding performance tasks, independently rated project work, and longer-term assessment would help determine whether students can transfer the reasoning practiced in class to unfamiliar problems. Such evidence would also clarify the relationship between perceived innovation and demonstrated problem-solving performance.

Interpreting the discussion sequences

The transitions among ideation, classification, connection, and solution generation suggest that organizing ideas deserves attention alongside generating them. The classification-to-connection transition was particularly pronounced, and connection was followed by solution generation more often than expected. This pattern is compatible with an instructional approach in which students first distinguish types of ideas and then examine useful relationships among them. However, the adjacent transitions do not establish a complete pathway or show that the pathway predicts project quality.

The reciprocal transitions between stating and defining a problem also suggest that problem formulation remained active during discussion. Students did not simply specify a problem once and then proceed to a solution. They returned to its boundaries and expression. Instructors could use this observation to allow time for clarification before requiring a final proposal. Similarly, transitions involving perspective change and topic departure indicate a need to examine what students do when a conversation moves away from its immediate focus. A departure may expand the problem space, distract from it, or do both at different moments.

The large Gen-to-Gen residual requires a restrained interpretation. It shows that solution-generation codes tended to persist across adjacent sampled intervals. It does not demonstrate that generating one solution caused additional solutions. Establishing that claim would require event-level segmentation, identifiers for distinct solutions, and a direct relationship between sequences and independently assessed outputs. Comparing stronger and weaker projects would also be necessary before describing a sequence as characteristic of superior performance.

Flow without consistent perceived control

The flow responses draw attention to a possible tension between involvement and control. Students who described flow emphasized the clarity of the entrepreneurial goal and the challenge of imagining an unfamiliar environment. At the same time, the account of limited control suggests that an interesting task may leave students uncertain about how to move forward. This interpretation is consistent with the course's open-ended character, but it remains tentative because the response denominator and measurement properties were not established.

Future course design could make the route from an idea to a prototype more explicit. Intermediate milestones might ask students to specify a user, describe an interaction, identify necessary resources, and test one part of the proposal. Feedback at each milestone could help students judge their progress. This is an instructional implication of the observed combination of engagement and uncertainty, not an intervention effect tested in the present study. Flow and control should also be measured with a clearly documented instrument whose item structure fits the discussion context.

Micro entrepreneurship as a course outcome

The completed projects show that students could turn broad technological themes into concrete educational and entertainment applications. The virtual Vietnamese supermarket is a useful example because it linked a familiar language-learning activity with an immersive setting and a proposed user experience. Other projects explored movement, content generation, practice, and performance. These artifacts are meaningful course outcomes even when they have not become operating businesses.

The distinction between a proposal, a functioning prototype, and a viable enterprise is necessary when interpreting micro entrepreneurship education. Infrastructure, development effort, equipment, and access to appropriate expertise can still impose substantial costs. The study did not measure revenue, customer adoption, sustained use, or venture survival. Future research could follow projects beyond the semester and examine whether students revise their proposals after user feedback or continue development in a different context.

Limitations and future research

Several limitations constrain the conclusions. First, the single-group design cannot rule out maturation, concurrent learning, testing effects, or other explanations for pretest–posttest change. The two course offerings were pooled, and their separate sample characteristics and exposure conditions were not available for analysis. Generalization is further limited by the small sample and the course-specific setting.

Second, the competency outcomes were self-reported. The available summaries do not establish the UCAN scale version, item counts, response anchors, or reliability in this sample. The composition of the reported overall score also requires clarification. Reporting effect sizes derived from t statistics improves interpretation but does not replace access to paired observations, confidence intervals, and assumption checks. Multiple domain tests were exploratory and were not adjusted for multiplicity.

Third, the discussion corpus was selected with attention to stronger projects. The number of groups and sessions represented, their durations, and the handling of boundaries between recordings require fuller

documentation. The 5,735 observations are temporally and socially dependent, not independent participants. Repeated time-sampled codes may reflect the duration of an activity, and the cellwise residual tests do not account for all inferential complications of clustering or multiple comparisons. The interrater agreement estimate also needs to be interpreted alongside the amount of independently double-coded material and the timing of consensus discussion.

Fourth, the flow questionnaire was adapted to a new context without reported psychometric validation. Its proposed item groupings do not align consistently with item wording, particularly for perceived control and self-consciousness. The qualitative description of absent control also varies in scope across the course account. These issues prevent a strong claim about the prevalence, intensity, or change of flow or perceived control. Routine teaching evaluations and selected favorable comments cannot resolve these measurement limitations.

Future work should use a comparison condition or a carefully documented repeated-cohort design, specify the discussion sampling procedure, and assess project quality independently. A coding analysis that distinguishes continuing activity from new events would help interpret self-transitions. Linking discussion patterns to student-level outcomes and project ratings would provide a stronger test of the proposed relationship between inquiry and solution development. Automated transcription or coding may reduce workload, but its performance should be evaluated against human coding before it is used to support research conclusions.

Conclusion

An 18-week course combined philosophical inquiry, creative problem solving, and metaverse microentr epreneurship through collaborative discussion and project development. Students reported higher innovation, communication, and information technology application scores after the course, whereas the reported statistics did not show a significant improvement in problem solving. Selected discussions featured recurring transitions involving idea organization, connection, and solution generation. Some students described flow, but perceived control remained a concern. The study provides a documented instructional approach and exploratory evidence about its associated processes and outcomes. Controlled evaluation, clearer measurement, and direct assessment of project quality are needed to determine when and for whom the approach supports transferable learning.

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ChatGPT (OpenAI) was used to assist with English translation, language editing, manuscript organization, and checks of reported summary statistics. The authors are responsible for verifying and approving the manuscript's content, references, and interpretation of results.

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Appendix A: Flow questionnaire for philosophical inquiry discussions

This questionnaire was adapted for the course with reference to Kiili (2006). The English wording below translates the Chinese questionnaire used in the course; it is not presented as a separately validated English instrument.

Instructions: Please answer the following questions based on your experience of discussing metaverse micro entrepreneurship through philosophical inquiry. The questions concern thoughts and feelings that you may have experienced during the discussion. Reflect on your own experience when responding.

1. The philosophical-inquiry discussion challenged me, but I believed that my abilities could meet the challenge.
2. I clearly knew what I wanted to do and what goals I wanted to achieve.
3. I knew how well I was performing in the philosophical-inquiry discussion.
4. I was completely focused on the philosophical-inquiry discussion.
5. I felt completely in control of my participation in the philosophical-inquiry discussion.
6. I was not concerned about what others thought of my performance in the philosophical-inquiry discussion.
7. My perception of time changed; it may have seemed faster or slower.
8. I greatly enjoyed the experience of philosophical inquiry.
9. The goals of the philosophical-inquiry discussion were clear.
10. I could judge the depth of my philosophical thinking from my own performance.
11. It was effortless for me to concentrate on the philosophical-inquiry discussion.
12. I had a sense of control over my actions.
13. I was not worried about my performance during the philosophical-inquiry discussion.
14. Time seemed different from the way it normally does.
15. I enjoyed the feeling of philosophical inquiry and wanted to experience it again.
16. I was fully attentive during the philosophical-inquiry discussion.
17. The philosophical-inquiry discussion made me feel great.
18. I was completely immersed in the philosophical-inquiry discussion.
19. I found this philosophical-inquiry experience very valuable.

After reading the following description, respond to this statement: “I experienced a clear sense of flow during philosophical inquiry.”

Flow refers to a state of deep involvement that people may experience during an activity. For example, a football player may become so absorbed in a match that everything else seems unimportant and the activity proceeds smoothly. A person watching a film may similarly identify with a character and become immersed in the story, temporarily losing awareness of the surroundings. An activity that produces flow fully engages a person for a period of time. Time may seem to change, and the activity itself becomes the main focus of attention. Flow may arise and subside during an activity and is described as intrinsically enjoyable.

Open-ended question 1. If you experienced flow, which aspects of philosophical inquiry contributed to that experience?

Open-ended question 2. If you did not experience flow, which aspects of philosophical inquiry prevented it?

Table A1: Item groupings proposed in the course questionnaire

Proposed grouping	**Item numbers**
Challenge	1
Goal orientation	2, 9
Self-assessment	3, 10
Concentration	4, 11, 16
Sense of control	5, 6, 12
Confidence	1, 13
Time perception	7, 14
Enjoyment	8, 15, 17, 18, 19

The original grouping is retained for transparency, not endorsed as a validated scoring key. Item 5 explicitly concerns control, whereas item 6 concerns others' judgments. Item 1 appears in two groupings. Response anchors and a scoring rule were not supplied. No subscale scores are calculated from this mapping.

The original interpretive guidance associated possible facilitators with challenge (item 1), clear goals (items 2 and 9), self-assessment (items 3 and 10), concentration (items 4, 11, and 16), altered time perception (items 7 and 14), and enjoyment (items 8, 15, 17, 18, and 19). Possible obstacles included insufficient challenge, unclear goals, difficulty assessing one's performance, poor concentration, limited control, concern about others' views, and low interest or enjoyment. These associations were proposed for interpreting the course questionnaire and were not validated as a factor structure.

Appendix B: Correlations among UCAN competency domains

Table B1: Pretest correlations among UCAN domains

Domain	1	2	3	4	5	6	7	8
1	1.000							
2	0.780	1.000						
3	0.714	0.595	1.000					
4	0.610	0.526	0.830	1.000				
5	0.823	0.748	0.646	0.622	1.000			
6	0.705	0.625	0.681	0.582	0.784	1.000		
7	0.635	0.603	0.712	0.765	0.640	0.618	1.000	
8	0.708	0.602	0.518	0.421	0.707	0.598	0.668	1.000

Domains: 1 = communication; 2 = continuous learning; 3 = interpersonal interaction; 4 = teamwork; 5 = problem solving; 6 = innovation; 7 = work responsibility and discipline; 8 = information technology application.

Table B2: Posttest correlations among UCAN domains

Domain	1	2	3	4	5	6	7	8
1	1.000							
2	0.610	1.000						
3	0.708	0.621	1.000					
4	0.808	0.495	0.643	1.000				
5	0.789	0.556	0.646	0.676	1.000			
6	0.780	0.746	0.785	0.699	0.828	1.000		
7	0.777	0.669	0.836	0.694	0.751	0.805	1.000	
8	0.662	0.711	0.631	0.451	0.646	0.696	0.739	1.000

Domains: 1 = communication; 2 = continuous learning; 3 = interpersonal interaction; 4 = teamwork; 5 = problem solving; 6 = innovation; 7 = work responsibility and discipline; 8 = information technology application.

The matrices reproduce the reported coefficients. Diagonal entries are 1.000, and the upper triangles are omitted because the matrices are symmetric. Correlation type, complete-case sample size, confidence intervals, and significance levels were not documented in the available summaries. The matrices are therefore used descriptively.

Appendix C: Additional instructional documentation

The following images document instructional resources and activities associated with the course (https://www.youtube.com/watch?v=o8GtWDGaxOc). They provide context for the learning design and are not additional outcome measures. Chinese text visible within original screenshots and photographs is retained as part of the documented materials; English captions explain the relevant activity.



Figure C1: Still image from the instructor's recorded introduction to philosophical thinking. The visible Chinese subtitle identifies Rodin's The Thinker.



Figure C2: Classroom documentation. Labels identify a microentrepreneurship talk, LEGO activities, philosophical-inquiry discussions, making thinking visible, avatar and NFT creation, an elementary-school English activity, and metaverse computational thinking.



Figure C3: English learning outreach activity conducted at an elementary school in Taoyuan on November 19, 2022.