



ORIGINAL RESEARCH ARTICLE

## Bridging Multi-Campus Distances with Digital Closeness: An Empirical Dive into Face-to-Face Extended (FTFx) Instruction

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### ABSTRACT

In the context of increasing university mergers, this study investigates the use of technology to facilitate cross-campus teaching interaction and enhance student learning experiences. Focusing on National Yang Ming Chiao Tung University (NYCU), we compared Face-to-Face Extended (FTFx), traditional Face-to-Face (FTF), and 2D Virtual Classroom (VC) course modalities. Employing a quasi-experimental design, we analyzed the flow state and discussion behaviors of students enrolled in the "Learning and Reading Comprehension Strategies" course during "World Café" discussions in 2022 and 2023. Data were collected through questionnaires and classroom video recordings, and analyzed using quantitative content analysis and lag sequential analysis. Results indicated no significant differences in flow state and discussion behaviors between FTFx and FTF courses, both of which were significantly higher than VC courses. Discussion sequences were similar across FTFx, FTF, and VC. The findings suggest that the FTFx model is a viable solution for synchronous extended classrooms in multi-campus universities, promoting cross-campus resource sharing and student interaction while maintaining the benefits of traditional face-to-face instruction. This study provides insights for the future development of higher education. ©authors

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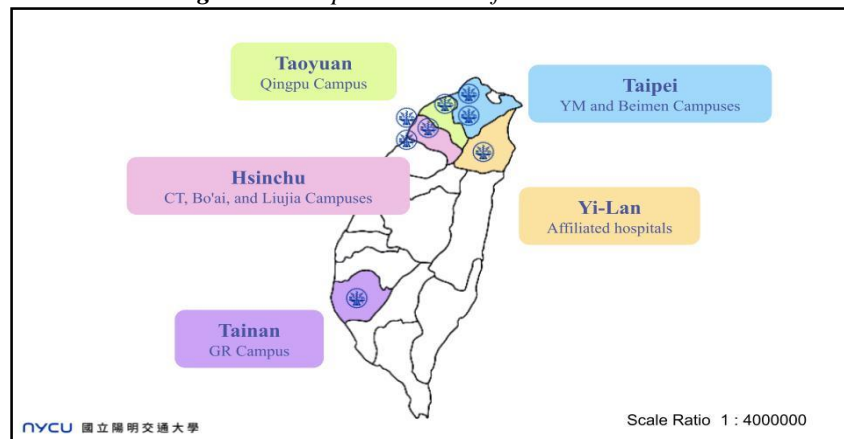
## 1. Introduction

### 1.1. The Tidal Wave of University Mergers

In the shifting terrain of higher education, university mergers have taken center stage. Institutions worldwide are consolidating, with aspirations of enhancing academic prestige, financial resilience, and curriculum breadth. The millennium dawned with Peking University's merger in 2000, and the trend cascaded globally, from Osaka in 2007 to Strasbourg in 2009. Recent examples from the U.S. demonstrate this momentum, with notable consolidations like that of Thomas Jefferson University in 2017 and the University of Nevada in 2022. While these mergers promise a host of benefits, they also present challenges such as ensuring strategic alignment, managing stakeholder impact, and navigating the complexities of cultural integration.

Similarly, Taiwan experienced its wave of mergers, notably with the National Taichung University of Science and Technology in 2011, the University of Taipei in 2013, and the National Kaohsiung University of Science and Technology in 2018 that brought together three regional public polytechnics. Our study focuses on the merger of National Chiao Tung University and National Yang Ming University, resulting in the National Yang Ming Chiao Tung University (NYCU) on February 1, 2021. With its nine campuses and a student body of over 20,000, NYCU faced considerable challenges in the aftermath of the merger, particularly in integrating cross-campus course resources. Unlike the 2016 merger of National Tsing Hua University and National Hsinchu University of Education, which benefited from their geographical proximity, the primary campuses of NYCU are an hour and a half apart. This distance has raised transportation costs and posed logistical challenges for students, even with the promise of increased cross-campus course opportunities.

Figure 1. Campus locations of NYCU in Taiwan



### 1.2 The Evolution and Significance of Seamless Interactivity in Distance Education

#### 1.2.1 Historical perspective and modern day challenges

Distance education has evolved from correspondence courses to advanced online platforms, ensuring global knowledge access. The essence of this transition is dynamic, engaging interactivity. Harvard Business School's 2015 HBX LIVE initiative utilized over 60 cameras for high-tech synchronous learning, aiming to simulate in-person sessions. By 2019, it became "Harvard Business School Online" (HBS online), earning favorable feedback compared to other online courses (City Square Associates, 2019).

*Figure 2. The launch of HBX*

Harvard Business School Online. (2015). *HBX Live: The first year*. <https://online.hbs.edu/blog/post/hbx-live-the-first-year-infographic>

Yet, the COVID-19 pandemic reshaped education. With social distancing mandates, rapid online transitions became essential, emphasizing the need for seamless interactivity. Fontichiaro and Stephens (2021) underscored the challenges faced by parents adjusting to home-based online learning, highlighting issues from technical glitches to increased scrutiny of teachers. The pandemic has intensified existing inequalities, such as the digital divide, emphasizing the need for robust synchronous classrooms (Mangione & Cannella, 2021; DeMatthews, Knight, Reyes, Benedict, & Callahan, 2020).

### *1.2.2 The nature of "virtuality" in education*

Debates around online vs. in-person learning gained momentum post-pandemic. Some findings, like Dillon et al. (2021), observed parallel outcomes for both mediums. Delving into "virtuality," scholars have explored the intricacies of technology-mediated interactions. Schweitzer and Duxbury (2010) suggest levels of "virtuality" for enriched student engagements. Furthermore, as projected by Yang and Luo (2020), future classrooms might be shaped by advances like 5G/6G, blurring the lines between virtual and physical realms. Yet, educational institutions have been sluggish in harnessing advanced telecommunication systems, as observed by the World Economic Forum (2019).

### *1.2.3 Exploring distance classroom design*

Since the early 21st century, video conferencing has connected classrooms, aiding teaching resource exchanges. Universities, including in Israel, used satellite transmissions for cross-country classroom interactions (Pachler, Bachmair, & Cook, 2010). However, constraints like connection costs limited its spread. The rise of mobile learning and virtual environments like Second Life became central to 21st-century tech advancements, overshadowing synchronous inter-campus learning's importance (Loureiro & Bettencourt, 2014; Loureiro, Santos, & Bettencourt, 2012). Rutgers University's 2017 "telepresence split classroom" initiative aimed to reduce commute times between its campuses. While its concept was appreciated, technological complexities and teachers' adaptation challenges restricted its broader adoption (Tate, 2017). This highlights the need for a balance between innovation and user-friendly educational solutions.

### *1.2.4 Evolving classroom discussions in the digital age*

The pandemic led to major shifts in classroom dynamics. Video conferencing tools like Cisco Webex, Google Meet, and Zoom evolved to mimic classroom settings and enhance teacher-student, student-student, and student-content interactions (Bernard et al., 2009). Despite these

advances, the benefits of in-person classrooms remain unmatched. Research accentuates the importance of physical classroom nuances in shaping student behavior (Ramlatchan & Watson, 2020; Ramlatchan & Whitehurst, 2019). For instance, van den Berg et al. (2012) found closer seating arrangements in classrooms correlated with reduced disputes and heightened mutual acceptance among students. The "World Café" model, which emphasizes deep discussions among 6-10 participants, resembles the traditional "idea circle." Esteemed scholars such as Gambrell and Almasi (1996) and Clark and Mayer (2008) have highlighted the value of feedback and Computer-Supported Collaborative Learning (CSCL). Using Brown and Isaacs' (2005) World Café concept, research has offered guidelines to amplify the benefits of collective intelligence and diverse opinions.

### 1.3 Research Hypothesis

In the context of the World Café, this study explores the feasibility of various classroom settings, with a particular emphasis on the FTFx (video-extended face-to-face) course design. It juxtaposes the FTFx approach with traditional Face-to-Face (FTF) and Video Conference (VC) methods.

#### Hypothesis 1:

- **H1-1:** Learners' flow state in the FTFx environment is comparable to that in the traditional FTF setting.
- **H1-2:** The flow state of learners in the FTFx environment exceeds that of the VC instructional mode.

#### Hypothesis 2:

- **H2:** Observable differences in students' learning behaviors across the FTF, FTFx, and VC modalities can be identified. Particular focus will be placed on any distinct learning behaviors that arise in the FTFx environment in comparison to the other two.

## 2. Method

This study followed a quantitative quasi-experimental design. Three analytical methods, survey, quantitative content analysis (QCA) (Henri, 1992) and lag sequential analysis (LSA), were employed in the study.

### 2.1. Participant Selection and Demographics

#### 2.1.1. NYCU's unique challenge

Live streaming in classrooms to facilitate interactivity between distant students and teachers has been explored before. Post-merger, NYCU initiated the "Cross-Campus Course Exchange Promotion Program." To simplify inter-campus commutes, NYCU provided 14 daily shuttle services and dormitory options across campuses. Concurrently, NYCU introduced four cross-campus course modalities, including synchronous video-conference courses, hybrid courses, and both synchronous and asynchronous fully online courses (Table 1).

**Table 1.** NYCU cross-campus course offerings

Modalities	2021 Spring		2021 Fall		2022 Spring		2022 Fall		2023 Spring	
Campus	CT	YM	CT	YM	CT	YM	CT	YM	CT	YM
In-classroom instruction with remote technology										
Video Conferencing	3(9)	7(16)	3(8)	11(28)	7(17)	6(13)	4(12)	6(12)	3(7)	6(12)
Hybrid	11(31)	1(2)	15(40)	9(18)	9(23)	13(30)	13(36)	13(28)	18(50)	21(47)
Fully online (students learned separately)										
Synchronous	6(18)	-	3(5)	4(8)	2(4)	5(10)	2(4)	2(4)	4(9)	2(5)
Asynchronous	-	3(6)	1(2)	2(4)	1(3)	3(7)	-	-	1(3)	5(10)
Total	20(58)	11(24)	22(55)	26(58)	19(47)	27(60)	19(52)	21(44)	26(69)	34(74)

Note. Credit hours are in parentheses.

Since the program's start, roughly 56 cross-campus courses were offered each term, aiming to grant students access to distance learning resources from their home campuses. The favored classroom modalities were hybrid and video-conference distance courses, which upheld the traditional teaching format. In video-conferencing, students viewed broadcasts from other campuses, while in hybrid courses, remote students joined through netmeeting tools. Notably, except for fully online synchronous courses, one end was usually more passive. The COVID-19 pandemic added complexity, making post-pandemic modality selection crucial in cross-campus course planning.

2.1.2. *Selecting an interactive discussion course*

The course 'Learning and Reading Comprehension Strategies' (LRCS), a spring elective, uses the “Tao of Learning (TOL)” for flipped classrooms. TOL is a localized version of MOOC—Coursera’s “Learning How to Learn” tailored for Chinese-speaking learners (Chen & Oakley, 2020). LRCS adopts a blended approach, merging 8 weeks of online content with three in-person 'World Café' meetings post-orientation. Catering to foundational learning strategies, the course attracts a wide academic audience, fostering discussions on broad topics (Clark & Mayer, 2008). A significant challenge is maintaining discussions when shifting from face-to-face (FTF) and video conferencing (VC) to an extended face-to-face (FTFx) format.

Table 2. LRCS units and World Café topics

Weekly units	Café topics	2022	2023
1. What is Learning? 2. Forgetting and Enhancing Memory	Event 1	3 FTF tables	1 FTFx & 2 FTF tables
	1. Creativity and Their Origins		
	2. Your Passion Compass 3. Forgetting and Memorizing		
3. Chunking and Motivation 4. The Habit of Learning 5. Effective Reading and Writing	Event 2	3 FTF tables	3 VC tables
	1. Defeating Procrastination		
	2. Establishing Good Habits 3. To Write is to Truly Understand		
6. Study and Testprep Techniques 7. Teaching benefits both teacher and student	Event 3	3 VC tables	1 FTFx & 2 FTF tables
	1. Life Turnaround		
	2. Reading Effectively 3. Teaching Benefits Both Teacher and Student		

During World Café, participants rotate between themed discussions every 25 minutes, guided by table masters. From 2022 to 2023, these sessions held steady themes but varied in delivery—mixing FTF, VC, and FTFx. Participants should complete TOL videos and quizzes before sessions. On meeting days, they can attend the CT or YM campuses.

2.1.3. *Defining control and experimental cohorts*

In 2022, 22 students (8 males and 14 females), mostly from CT, formed the control group (FTF and VC). Meanwhile, 2023 had a diverse 38-student cohort (19 males and 19 females) from CT and YM. This year, some sessions introduced the FTFx intervention, with others as control sessions.

## 2.2. Modalities Under the Microscope

### 2.2.1. Classic face-to-face (FTF) interaction

In classic FTF sessions, seating arrangements followed Marx et al.'s (1999) recommendations, using a circular setup. The 2022 sessions accommodated 7 to 8 students per table (Figure 2). In 2023, there were about 9 students at CT campus tables and 3 at YM campus tables. To ensure diverse interactions, students selected their discussion table sequences upon arrival. This was based on the Latin square's six combinations, ensuring an even distribution of participants and diverse interactive scenarios.

*Figure 3. World Café FTF sessions in 2022 (left) and 2023 (right) at CT campus*



### 2.2.2. The mechanics of FTFx interaction

FTF<sub>x</sub> sessions similarly adhered to Marx et al.'s (1999) recommendations, utilizing a semi-circular desk arrangement. Adjustments were made to align video screens, creating the illusion of a complete circle, as depicted in Figure 4.

*Figure 4. FTF<sub>x</sub> sessions in CT (left) and YM (right) campuses in 2023.*



Equipment underpinning the FTF<sub>x</sub> setup included:

- CT campus:
  - Camera: Lumens VC-B11U
  - Display: ViewSonic IFP8652-1A (4K LCD smartboard)
  - Audio: AT-CSP5 (Bluetooth call speaker)
  - Video Conferencing: Cisco Webex
- YM campus:
  - Camera: Lumens VC-B11U
  - Display: HP ultra short throw projector
  - Audio: AT-CSP5 (Bluetooth call speaker)
  - Video Conferencing: Cisco Webex

Supplementary video setups, like the AVer CAM520 Pro2 at CT campus and the POLYCOM Group 310 at the YM campus, provided classroom live-streaming capabilities, enabling seamless instructor oversight and comprehensive student communication.

### 2.2.3. The VC classroom dynamics

Virtual classroom (VC) sessions utilized the role-playing game-based platform, GatherTown (Zhao & McClure, 2022). This 2D metaverse environment, as defined by Hwang & Chien (2024), is illustrated in Figure 5. Researchers pre-designed a map to ensure participants within specific round discussion zones (Marx et al., 1999) could exclusively hear conversations and view shared content. In 2022, VC tables accommodated 8 students, increasing to 12 in 2023. Materials were digitized into electronic whiteboards and documents. Discussion sequences were provided to students through pre-class announcements, which included GatherTown operating instructions and relevant links.

Figure 5. VC sessions in 2023



## 2.3. Data Collection

This section delves into assessing the variances in students' flow state and learning behaviors across three classroom modalities: FTFx, FTF, and VC in the context of LRCS.

### 2.3.1. Quantifying flow and engagement

The study explored three distinct vantage points, with the primary focus on the concept of flow. This analytical perspective is rooted in Csikszentmihalyi's flow theory (1990), which describes an individual's deep engagement and genuine joy in an activity, resulting in an optimal experience. The flow scale (FS), developed by Pearce et al. (2005) and adapted for participative discussions similar to those in the World Café, was employed. FS, structured on a five-point and eleven-item Likert scale, assesses learner engagement depth during World Café discussions. It comprises two core pillars: The Control Factor and the Enjoyment & Engagement Factor. The scale's robustness is evident in its satisfactory reliability, with Cronbach's  $\alpha$  values of 0.79 and 0.86. To capture real-time experiences, students completed the FS immediately after each Café session.

2.3.2. Video Analysis in classroom behavior evaluation

The study used Classroom Video Analysis (CVA) to assess classroom dynamics. Unlike direct observations, CVA offers a lasting record for multiple evaluations. Wang and Han (2015) highlighted its accuracy in documenting speech, and Froiland & Smith (2014) its ability to track student actions. The pandemic led to its lesser use due to the pivot to online teaching (Manning, Sheehy, & Ceballos, 2020; Juarez & Critchfield, 2021). The blend of AI with CVA is emerging. Some research utilized cameras to gauge student engagement in classrooms. In digital classrooms, however, viewers tend to focus on screens, possibly underestimating engagement.

To counter this, Narayanan, Rangan, & Gopalakrishnan (2019) implemented real-time image adjustments, ensuring perceived eye contact on-screen, emphasizing two considerations: investigating interactions in synchronous classrooms, and the camera's auto-focus effect on mutual engagement perception. Guiding our method, the coding model by Jacobs, Kawanaka, and Stigler (1999) was pivotal in coding FTFx, FTF, and VC session videos. Considering Chen and Yeh (2021) used the Interaction Analysis Model (IAM) by Gunawardena et al. (1997) for TOL forum discussions, this study adopted IAM with additions. Recognizing the "table master" in World Café, a specific code for their actions was added. Also, due to disruptions in FTFx and VC, a code for "Off-topic chats and interruptions" was introduced, detailed in Table 3.

**Table 3.** Knowledge Construction Levels of Gunawardena et al. (1997, p. 414)

Level	Description	Potential discussions
A1	Sharing and comparing of information	<ol style="list-style-type: none"> <li>1. Statement of observation or opinion.</li> <li>2. Agreement from one or more participants.</li> <li>3. Corroborating examples from participants.</li> <li>4. Questions and answers to clarify statements.</li> <li>5. Definition, description, or problem identification.</li> </ol>
A2	Exploration of dissonance	<ol style="list-style-type: none"> <li>1. Identifying and stating disagreement areas,</li> <li>2. Clarifying disagreement sources and extents through Q&amp;A,</li> <li>3. Restating the participant's position, possibly advancing it with references to experience, literature, and data.</li> </ol>
A3	Negotiation of meaning	<ol style="list-style-type: none"> <li>1. Negotiation or clarification of term meanings,</li> <li>2. Determining relative argument weight,</li> <li>3. Identifying agreement areas among conflicting concepts,</li> <li>4. Proposing and negotiating compromise or co-construction statements,</li> <li>5. Proposing integration or accommodation of metaphors or analogies.</li> </ol>
A4	Testing synthesis	<ol style="list-style-type: none"> <li>1. Testing synthesis against "received fact" from participants or culture,</li> <li>2. Testing against existing cognitive schema,</li> <li>3. Testing against personal experience,</li> <li>4. Testing against formal collected data,</li> <li>5. Testing against contradictory literature testimony.</li> </ol>
A5	Agreement statements and applications	<ol style="list-style-type: none"> <li>1. Summarizing agreements,</li> <li>2. Applying new knowledge,</li> <li>3. Metacognitive statements by participants indicating changes in their knowledge or cognitive schema due to the conference interaction.</li> </ol>
B	Table master initiations	<ol style="list-style-type: none"> <li>1. Greetings and introductions</li> <li>2. Appreciation and closing</li> <li>3. Survey administration</li> </ol>
C	Off-topic chats and interruptions	<ol style="list-style-type: none"> <li>1. Gossips and interruptions</li> <li>2. Resolving logistics (e.g. seat arrangement) or technical issues.</li> </ol>

Note: B and C code were added in the study.

Classroom recordings for this study were taken during World Café sessions led by table master A. Excluding one VC session due to file corruption, there were six FTFx, six FTF, and five VC recordings, totaling seventeen videos, each approximately thirty minutes long. Two independent coders assigned codes at 20-second intervals throughout each video. The average

Cohen's Kappa (1960) value was 0.89, indicating exceptionally strong intercoder consistency according to Landis and Koch (1977) benchmarks.

### 3. Finding

#### 3.1. Comparative Insights: FTFx vs. FTF vs. VC

##### 3.1.1. Flow experience across the modalities

The study analyzed students' flow experience across FTFx, FTF, and VC modalities. Of 476 valid responses, 177 were from 2022 and 299 from 2023. Statistical tests evaluated mean differences and the influence of different variables on flow.

*Table 5. Summary of LCRS's students flow in the World Café discussions*

		Responses	<i>M</i>	<i>SD</i>
2022	FTF	117	46.97	5.28
	VC	60	47.60	5.75
	subtotal	177	47.18	5.44
2023	FTF	131	44.08	6.82
	FTFx	66	44.42	6.08
	VC	102	41.24	6.96
	subtotal	299	43.19	6.84
Total		476	44.67	6.63

The study used the FS with a maximum score of 55 points. As detailed in Table 5, students' flow state ( $M = 44.67$ ,  $SD = 6.63$ ) averaged 4.06, indicating high flow during World Café discussions. The 2022 cohort ( $M = 47.18$ ,  $SD = 5.11$ ) had higher flow than the 2023 cohort ( $M = 43.19$ ,  $SD = 6.84$ ),  $t(434.79) = 7.02$ ,  $p < .001$ . Due to significant differences between cohorts and potential biases, the analysis mainly covered the 2023 cohort, focusing on classroom modalities.

In 2023, students had nine sessions: two FTFx, four FTF, and three VC discussions. This rotation ensured modality comparison within the same academic year, reducing biases.

*Campus Differences:* Flow scores between CT ( $M = 43.07$ ,  $SD = 6.63$ ) and YM campuses ( $M = 43.75$ ,  $SD = 6.84$ ) were not significantly different,  $t(297) = 0.67$ ,  $p = 0.51$ .

*Impact of Table Masters:* Comparing table master A ( $M = 43.30$ ,  $SD = 6.71$ ) to others ( $M = 43.13$ ,  $SD = 6.92$ ) showed negligible difference,  $t(297) = 0.20$ ,  $p = 0.84$ , indicating the table master's identity had little effect on flow.

*Physical Presence of Table Master A:* For the 2023 cohort, the presence of table master A in the main vs. extended classroom showed no significant flow difference,  $t(64) = 0.85$ ,  $p = 0.40$ .

In 2023, factors like campus origin, table master identity, or their physical presence didn't affect flow levels. Consequently, the focus shifted to comparing classroom modalities: FTFx, FTF, and VC.

*Classroom Modality Differences:* ANOVA indicated classroom modality impacts flow ( $p < 0.01$ , see Table 6). Post-hoc tests showed FTFx and FTF students had better flow than VC. However, flow in FTFx and FTF was similar.

**Table 6.** Comparison of FTF, FTFx, and VC in 2023 cohorts

Source	SS	df	MS	F	p	post-hoc
Between Groups	595	2	297.48	6.603	0.002**	FTFx > VC (p=0.012*) FTF > VC (p=0.006**) FTFx = FTF (p=0.945)
Within Groups	13335	296	45.05			
Total	13930	298				

\*p<.05, \*\*p<.01

Regarding hypotheses H1-1 and H1-2, FTFx classroom experiences were found to be on par with FTF classes in terms of flow and superior to VC courses. This outcome echoes the researcher's classification of FTFx as "video-extended face-to-face courses" and correlates with Lian's (2021) findings. With interactive technologies in play, FTFx combines the benefits of FTF sessions, offering immersive experiences, while extending the classroom's reach to ensure consistent experiences across varied settings.

### 3.1.2. Navigating discussion patterns across modalities

This study used a two-step method to understand differences in learning behaviors across three classroom modalities. Initially, a chi-square test discerned discussion behavior variations, followed by a lag sequential analysis for transition patterns. Video analysis showed FTFx behavior mirroring features from both other modalities, making its transition diagram a blend of them.

**Table 7.** Behavioral frequencies in Table Master A's discussion sessions

Level	Description	Freq.	%	Freq.	%	Freq.	%
A1	Sharing and comparing of information	384	38.63	357	33.87	305	34.74
A2	Exploration of dissonance	15	1.51	17	1.61	23	2.62
A3	Negotiation of meaning	41	4.12	29	2.75	6	0.68
A4	Testing synthesis	16	1.61	132	12.52	23	2.62
A5	Agreement statements and applications	230	23.14	132	12.52	71	8.09
B	Table master initiations	300	30.18	387	36.72	412	46.92
C	Off-topic chats	8	0.80	0	0	38	4.33

**Discussion Behavior Frequencies.** Table 7 shows discussion frequency in the World Cafés. Notably, FTF sessions had no "off-topic chats" (C), and "off-topic" discussions were brief, lasting <20 seconds. VC sessions faced disruptions due to internet and software/hardware issues. Chi-square results for H2 confirmed significant differences in behavior frequency proportions among modalities ( $\chi^2(12) = 330.23, p < 0.001$ ).

**Transition Analysis.** Lag sequential analysis (LSA) was employed to explore the transitions among behaviors. As per Bakeman and Gottman (1997), the number of events required for LSA is calculated as:

$$Ns = (9m^2) / (m-1)$$

Where *Ns* represents the minimum number of transition sequences, and *m* accounts for possible coding combinations. The study focused on IAM codes, excluding codes B and C, yielding 25

potential transition combinations. The minimum event transition sequence for analysis was set at 234. The classroom modalities achieved the following sequences: FTF 655 times, FTFx 674 times, and VC 418 times, meeting the minimum requirement for LSA (Li & Chen, 2022). Frequency conversion and statistical analysis for modality-specific observations were conducted using GSEQ 5 (Generalized Sequential Querier, Bakeman & Quera, 2011) software.

**Table 8** Adjusted Residuals (z-score) for IAM in three modalities

Mode		FTFx		FTF		VC	Mode
Modalities	Target		Knowledge construction				
			A1	A2	A3	A4	A5
FTF	Given	A1	15.63*	1.36	0.47	-8.95	-11.29
		A2	1.99*	2.41*	1.49	-2.1	-2.1
		A3	-2.77	1.49	6.2*	-0.87	0.55
		A4	-8.02	-1.47	-2.28	15.49*	-3.75
		A5	-11.11	-2	-2.15	-3.15	18.87*
FTFx	Given	A1	18.47*	1.29	-1.42	-2.1	-18.38
		A2	-0.15	1.18	3.37*	-0.61	-1.72
		A3	-2.15	0.1	10.45*	-1.03	-2.72
		A4	-4.2	-0.57	-0.96	8.28*	2.41*
		A5	-17.08	-1.61	-4.6	0.42	20.6*
VC	Given	A1	11.68*	1.58	-2.18	-1.8	-13.35
		A2	-1.05	1.63	6.62*	-1.19	-1.09
		A3	-0.21	-0.6	-0.3	1.21	-0.02
		A4	-3.87	-1.19	-0.6	5.39*	2.34*
		A5	-11.4	-2.06	-1.03	-0.85	15.93*

\* Denotes  $p$ -value  $<0.05$

**(1) FTF**

The sequence transition diagram (Figure 6) and adjusted residual table (Table 8) indicate that during FTF discussions, learners generally sustained the same interaction level for prolonged periods (A1→A1, A2→A2, A3→A3, A4→A4, A5→A5). FTF discussions often centered on A1, sharing information, until the table master intervened, guiding them through the other stages. Hence, these discussions usually remained focused on singular topics, rarely transitioning between interaction levels without facilitator input.

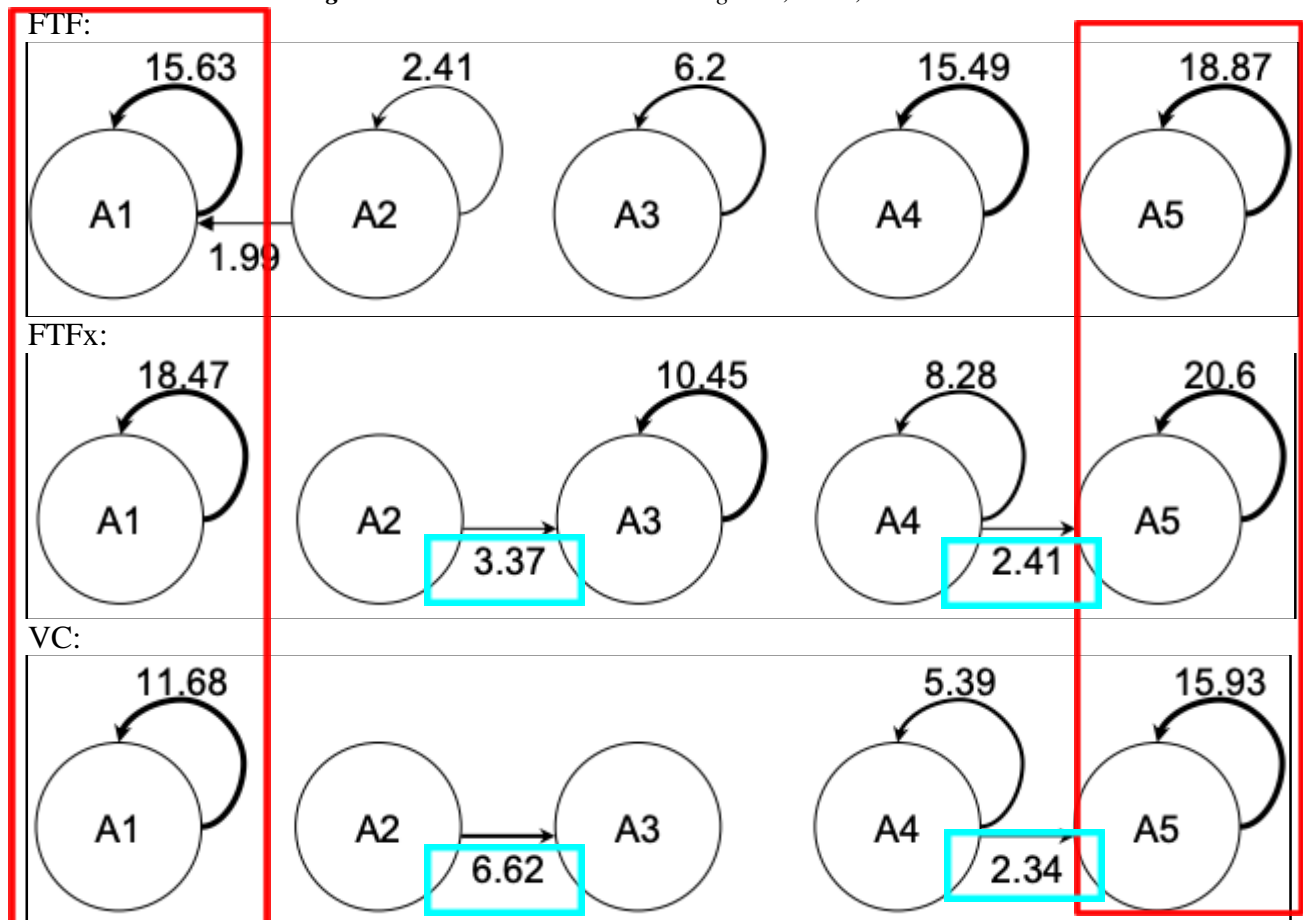
**(2) FTFx**

As inferred from Figure 6, FTFx discussion behaviors predominantly mirror those of FTF. However, additional transitions were observed, indicating knowledge construction level changes (A2→A3 and A4→A5). Within FTFx, discussions happened concurrently in two physical classrooms, necessitating efficient time management. As a result, participants actively summarized key conclusions within the allotted time, seamlessly moving discussions to the integration stage.

**(3) VC**

The transition diagram illustrates that VC discussions mainly retained the same IAM behaviors (A1→A1, A4→A4, A5→A5), but also showed a few transition events, closely resembling FTFx. Due to time constraints, VC participants primarily engaged in A1 behaviors. This led to a hurried conclusion towards the end of discussions (A5), often skipping intermediate stages.

Figure 6. Behavioral transitions among FTF, FTFx, and VC.



### 3.2. FTFx: A Confluence of FTF and VC Characteristics

In the 2023 cohorts, the flow experience remained consistent, irrespective of campus differences, table masters, physical presence, or modality. The FTFx modality combines behavioral patterns from both FTF and VC, demonstrating the capacity to maintain topic continuity while efficiently advancing discussions. A detailed analysis of behavioral transition diagrams across the three instructional modalities reveals distinct tendencies in the World Café discussions.

- 1. Initiation and Conclusion (A1→A1, A5→A5):** This trend is consistent across all three modes. As the World Café places a strong emphasis on individual expression, participants are encouraged to share their perspectives, making the initiation (A1) and conclusion (A5) stages crucial in the discussions.
- 2. Intermediate Discussion Stages (A2→A2, A3→A3, A4→A4):** The importance of these intermediate stages is most evident in FTF, followed by FTFx, and is less pronounced in VC. This order reflects the level of direct interaction in each mode. FTF discussions encourage participants to engage deeply in each stage, covering the entire IAM interaction model, while VC discussions prioritize the beginning and end, with less focus on intermediate stages.
- 3. Driving Discussions to Conclusions (A2→A3, A4→A5):** This trend is evident in both FTFx and VC. Following the IAM model's progression from A1 to A5, it highlights a tendency in FTFx and VC discussions to consolidate information and steer towards a conclusive summary. This aligns with the study's theme of virtuality, as emphasized by Powell et al. (2004) and Schweitzer & Duxbury (2010). Categorizing modalities by virtuality—FTF being the least virtual, FTFx intermediate, and VC the most virtual—it's clear

that FTFx effectively blends characteristics from both FTF and VC. The transition diagrams further underscore FTFx's integrative role, positioning it between FTF and VC.

### ***3.3 Harnessing the Potential of the FTFx Classroom Model***

As Mark Weiser (1991, p.94) elegantly captured: “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.” Drawing from this, the FTFx model seems poised to extend traditional face-to-face courses. Through an analysis of engagement patterns across varying classroom modalities, this research spotlights the necessity of adapting to the challenges following university mergers. The insights garnered indicate a direction where the FTFx model becomes a cornerstone for future interactive and enriching learning experiences.

#### ***4.1. Navigating the Future of Higher Education Through FTFx***

The results corroborate the potential of the FTFx classroom model, presenting it as a viable tool for resource sharing across multiple campuses. Echoing Weiser’s sentiment, the FTFx classroom seamlessly integrates itself, pointing towards its adoption as a staple in forthcoming educational methodologies.

##### ***4.1.1. Realizing the potential of cross-campus shared instruction***

Upon analyzing the impact of FTF, FTFx, and VC on student engagement during the 2022 and 2023 semesters, it was discerned that the flow state was notably higher in 2022. Classifying the levels of virtuality—with FTF possessing none, FTFx exhibiting a minimal degree, and VC being the most virtual—the 2022 semester's lower overall virtuality is explicable. This observation aligns with previous studies, such as Powell et al. (2004) and Schweitzer & Duxbury (2010), suggesting that high degrees of virtuality can potentially curtail team performance. Literature on classroom discussions, like Gambrell & Almasi (1996) and Clark & Mayer (2008), emphasizes the effectiveness of smaller group sizes ranging from 3 to 6 participants. Notably, the 2022 semester had fewer students than 2023, with group sizes aligning with optimal figures advocated in academic literature.

During the 2023 semester when FTFx was operational, no significant flow state disparities were observed among students from different campuses, those led by various World Café table masters, or between the primary and extended classrooms. This endorses the FTFx model's conception as an "extended face-to-face course" while maintaining congruence with traditional FTF in terms of student flow and virtuality. These results suggest that FTFx fosters efficient classroom discussions, promoting inter-campus interactions, while also addressing logistical challenges for students spread across different campuses.

##### ***4.1.2. Steering the FTFx blended learning trajectory***

This research explored disparities in student engagement behaviors across the FTF, FTFx, and VC modalities. While the flow state results of FTFx paralleled that of FTF, the impact of virtuality in the former couldn't be disregarded. In terms of virtuality, FTFx largely mirrored FTF's dynamics. However, physical separations and time limitations imposed by conferencing software prompted swift conclusions in discussions. This trend in both VC and FTFx discussions aligns with Schweitzer & Duxbury's (2010) findings regarding the negative implications of excessive virtuality.

#### ***4.2. Architectural and Design Considerations for Interactive Classrooms***

FTFx presents as a superior classroom design, with potential to reshape inter-campus face-to-face courses. This study highlights FTFx's advantages, notably saving students' time and travel costs. Effective FTFx design requires thoughtful architectural planning and tech equipment. As emphasized by the WEF (2019) report, creating a sense of shared space is

crucial for interactive learning. This research adopted Marx et al.'s (1999) seating suggestions to ensure student visibility. The recommended layout (refer to Figure 7) is semi-circular. For optimal discussions and group dynamics, each FTFx side should accommodate 5-7 students, capping at 10. Guardino and Fullerton (2010) stressed audio quality's importance. Recommended hardware for FTFx includes:

- **Video Cameras:** Wide-angle with flat viewing angle.
- **Screens:** Large LCDs with interactive whiteboard features.
- **Microphones:** Overhead array microphones.
- **Desks & Chairs:** Semi-circular or "M"-shaped, accommodating students and equipment.

*Figure 7. A prototype illustration of FTFx discussion classroom*



A consistent large-screen display across campuses is vital. The study showed different viewing angles can cause “continuity errors”. Challenges like video blurring highlight the need for a reliable network. Without it, even top-tier equipment fails.

#### **4. Conclusion**

##### ***Embracing the Future of Multi-Campus Education***

Multi-campus institutions are on the brink of an educational shift. This study highlights multi-functional classrooms supporting FTFx courses and bridging physical divides with superior audio, video, and network. Ahead, we foresee cross-campus experiences unhampered by physical separation.

##### ***5.1. Technological Innovations for Effective Learning***

This study emphasizes technological readiness for FTFx courses. Despite network challenges, 5G could offer uninterrupted learning. A move to FTFx-compatible software can improve user experience and resource use. VC, though behind in this study's flow experiences, has potential with home-based learning flexibility. Transitioning from traditional FTFx software, 3D virtual platforms, like the metaverse-inspired Universe by Viewsonic, with 3D avatars, could redefine interactive education.

## 5.2. Limitations and Future Directions

Our study's participant distribution posed a limitation; most were from CT and YM campuses in a 3:1 ratio. This bias might impact the generalizability of results. Future studies should prioritize balanced samples for holistic insights. We focused on discussion-based courses, particularly the World Café format. Feedback hinted at potential variations in FTFx's outcomes for other courses, like practical ones. This suggests further research on FTFx's adaptability in various course designs and addressing integration challenges in less-equipped classrooms. Our methods, based on Csikszentmihalyi's (1990) flow theory, need refinement. The flow scale missed nuances like attention spans. Supplementary tools could enhance future insights. The time-bound coding for discussions might overlook quick learning behavior shifts. A detailed, IAM-aligned coding might yield better results in future studies.

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## References

- Bernard, R. M., Abrami, P. C., & Borokhovski, E., et al. (2009). A meta-analysis of three types of interaction treatments in distance education. *Review of Educational Research*, 79(3), 1243-1289. <https://doi.org/10.3102/0034654309333844>
- Bakeman, R., & Gottman, J. (1997). *Observing interaction: An introduction to sequential analytics*. Cambridge University Press.
- Bakeman, R., & Quera, V. (2011). *Sequential analysis and observational methods for the behavioral sciences*. Cambridge University Press.
- Brown, J., & Isaacs, D. (2005). *The World Café: Shaping our futures through conversations that matter*. Berrett-Koehler.
- City Square Associates. (2019, January 8). HBX rebrands to Harvard Business School Online to help extend the reach of online programs. *Harvard Business School Online*. <https://online.hbs.edu/blog/post/hbx-rebrands-to-harvard-business-school-online>
- Chen, K.-Z., & Yeh, H. -H. (2021). Acting in secret: Interaction, knowledge construction and sequential discussion patterns of partial role-assignment in a MOOC. *Australasian Journal of Educational Technology*, 37(6), 41-60. <https://doi.org/10.14742/ajet.6979>
- Chen, K.-Z., & Oakley, B. (2020). Redeveloping a global MOOC to be more locally relevant: Design-based research. *International Journal of Educational Technology in Higher Education*, 17:9. <https://doi.org/10.1186/s41239-020-0178-6>
- Clark, R. C., & Mayer, R. E. (2008). Learning together virtually. In R. C. Clark (Ed.), *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning* (2nd ed.). Pfeiffer/John Wiley & Sons.
- Cohen, J. (1960). A coefficient of agreement for nominal scale. *Educational and Psychological Measurement*, 20(1), 37-46. <http://dx.doi.org/10.1177/001316446002000104>
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper and Row.
- DeMatthews, D., Knight, D., Reyes, P., Benedict, A., & Callahan, R. (2020). From the field: Educational research during a pandemic. *Educational Researcher*, 49, 398-402. <https://doi.org/10.3102/0013189X20938761>
- Dillon, E., Williams, B., Ajayi, A., Bright, Z., Rogers, Q. K-B. C., Lewis, M., Esema, J., & Clinkscale, B. (2021). Evaluating face-to-face vs. virtual pedagogical coding review sessions in the CS classroom: An HBCU case study. *2021 Conference on Research in Equitable and Sustained Participation in Engineering, Computing, and Technology*. <https://doi.org/10.1109/RESPECT51740.2021.9620586>
- Fontichiaro, K., & Stephens, W. S. (2021). Blurring the boundaries between home and school: How videoconference-based schooling places American education's cultural values at risk during COVID-19. *Journal of Children and Media*, 15(1), 96-100, <https://doi.org/10.1080/17482798.2020.1860101>
- Froiland, J. M., & Smith, L. (2014). Advancing the discussion about systematic classroom behavioral observation, a product review of Tenny, J. (2010). eCOVE observation software. *Journal of Attention Disorders*, 18(4), 385-391. <https://doi.org/10.1177/1087054712436585>

- Gambrell, L. B., & Almasi, J. F. (Eds.). (1996). *Lively discussions! Fostering engaged reading*. International Reading Association.
- Guardino, C. A., & Fullerton, E. (2010). Changing behaviors by changing the classroom environment. *Teaching Exceptional Children*, 42(6), 8-13. <https://doi.org/10.1177/004005991004200601>
- Hwang, G. J., & Chien, S. Y. (2024). Broad sense and narrow sense perspectives on the metaverse in education: Roles of virtual reality, augmented reality, artificial intelligence and pedagogical theories. *International Journal of Mobile Learning and Organisation*. <https://doi.org/10.1504/IJMLO.2024.10058828>
- Jacobs, J. K., Kawanaka, T., & Stigler, J. W. (1999). Integrating qualitative and quantitative approaches to the analysis of video data on classroom teaching. *International Journal of Educational Research*, 31(8), 717–724. [https://doi.org/10.1016/S0883-0355\(99\)00036-1](https://doi.org/10.1016/S0883-0355(99)00036-1)
- Juarez, B. C., & Critchfield, M. (2021). Virtual classroom observation: Bringing the classroom experience to pre-service candidates. *American Journal of Distance Education*, 35(3), 228-245, <https://doi.org/10.1080/08923647.2020.1859436>
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174.
- Li, S. -C., & Chen, K.-Z. (2022). Analysing behavioral sequences of online learners: Lag Sequential Analysis using GSEQ. In *SAGE Research Methods: Doing Research Online*. <https://dx.doi.org/10.4135/9781529607918>
- Loureiro, A., & Bettencourt, T. (2014). The use of virtual environments as an extended classroom – A case study with adult learners in tertiary education. *Procedia Technology*, 13, 97–106.
- Loureiro, A., Santos, A., & Bettencourt, T. (2012). Virtual worlds as an extended classroom. In C. S. Lányi (ed.), *Applications of Virtual Reality*, 89-108. InTech.
- Mangione, G. R. J., & Cannella, G. (2021). Small school, smart schools: Distance education in remoteness conditions. *Technology, Knowledge, and Learning*, 26, 845–865. <https://doi.org/10.1007/s10758-020-09480-4>
- Manning, T., Sheehy, K., & Ceballos, L. (2020). Making mentoring work online. *The Learning Professional*, 41(4), 56-58.
- Marx, A., Fuhrer, U., & Hartig, T. (1999). Effects of classroom seating arrangements on children's question-asking. *Learning Environments Research*, 2(3), 249–263. <https://doi.org/10.1023/A:1009901922191>
- Narayanan, R., Rangan, V. P., & Gopalakrishnan, U. (2019). Multiparty gaze preservation through perspective switching for interactive eLearning environments. *Multimedia Tools and Applications*, 78, 17461–17494. <https://doi.org/10.1007/s11042-018-7078-y>
- Pachler, N., Bachmair, B., & Cook, J. (2010). *Mobile learning: Structures, agency, practices*. Springer.
- Pearce, J. M., Ainley, M., & Howard, S. (2005). The ebb and flow of online learning. *Computers in Human Behavior*, 21(5), 745-771. <https://doi.org/10.1016/j.chb.2004.02.019>
- Powell, A., Piccoli, G., & Ives, B. (2004). Virtual teams: A review of current literature and directions for future research. *Database for Advances in Information Systems*, 35, 6-37. <https://doi.org/10.1145/968464.968467>
- Ramlatchan, M. & Watson, G. S. (2020). Enhancing instructor credibility and immediacy in the design of distance learning systems and virtual classroom environments. *The Journal of Applied Instructional Design*, 9(2). <https://doi.org/10.51869/92mrgsw>
- Ramlatchan, M., & Whitehurst, C. (2019). *The social presence benefits of synchronous, interactive video in online classes*. [https://members.aect.org/pdf/Proceedings/proceedings19/2019/19\\_27.pdf](https://members.aect.org/pdf/Proceedings/proceedings19/2019/19_27.pdf)
- Tate, E. (2017, March). Teaching in two places at once. *Inside Highered*. <https://www.insidehighered.com/digital-learning/article/2017/03/08/technology-allows-teaching-two-places-once>
- Schweitzer, L., & Duxbury, L. (2010). Conceptualizing and measuring the virtuality of teams. *Information Systems Journal*, 20(3), 267–295. <https://doi.org/10.1111/j.1365-2575.2009.00326.x>
- van den Berg, Y.H.M., Segers, E., & Cillessen, A. H. N. (2012). Changing peer perceptions and victimization through classroom arrangements: A field experiment. *Journal of Abnormal Child Psychology*, 40, 403–412. <https://doi.org/10.1007/s10802-011-9567-6>

- Wang, W., & Han, M. (2015). Quantitative analysis of the speech of the teachers and students in high school English classroom—based on information technology-based interaction analysis system. *Theory and Practice in Language Studies*, 5(10), 2107-2111. <http://dx.doi.org/10.17507/tpls.0510.18>
- Weiser, M. (1991). The computer for the 21st century. *Scientific American*, 265, 94-104. <https://doi.org/10.1145/329124.329126>
- World Economic Forum. (2019, July 2). *Top 10 Emerging Technologies 2019*. <https://www.weforum.org/reports/top-10-emerging-technologies-2019>
- Yang, F., & Luo, W. (2020). *Sharing cloud platform applied to teaching system reform based on “5G+Smart Education” innovation*. Proceedings of 2020 International Conference on Information Science and Education (ICISE-IE) (pp. 617-620).
- Zhao, X., & McClure, C. D. (2022). Gather.Town: A gamification tool to promote engagement and establish online learning communities for language learners. *RELC Journal*. <https://doi.org/10.1177/00336882221097216>