# Using Data Analytics to Investigate Attendees' Behaviors and Psychological States in a Virtual Academic Conference

**Jiun-Yu Wu*, Chen-Hsuan Liao, Tzuying Cheng and Mei-Wen Nian**
Institute of Education, National Chiao Tung University, Taiwan, R.O.C. // jiunyu.rms@gmail.com // abugu103@gmail.com // anke801211@gmail.com // iammo0715@nctu.edu.tw
*Corresponding author

(Submitted September 24, 2020; Revised October 28, 2020; Accepted December 13, 2020)

**ABSTRACT:** Amid the pandemic of coronavirus diseases, virtual conferences have become an alternative way to maintain the prosperity of the research community. This study investigated attendees' participatory behavior in a virtual academic conference (TWELF2020, Taiwan) and studied the interrelationship among their mastery experience, competence, and engagement to shed light on the development of virtual conferences. Data were collected based on 602 unique IDs via their unstructured trace data and 106 respondents to the post-conference questionnaire. Ten indices were derived from participants' unstructured log to describe the conference-based and session-based behaviors. Study results demonstrated that virtual conferences could facilitate the extended and deepened participation of the research community, nourish the participant-centered scholarship building, and create an engaging conference environment that reflects quality experiences regarding participants' mastery experience, competence, and engagement. The implications of the study can inform future virtual conference organization to provide more engaging and rewarding conference experiences for participants of all gender and academic ranks.

**Keywords:** Pandemic, Virtual conference, Mastery experience, Competence, Engagement

## 1. Introduction

Scholars' behaviors and learning activities change with the advancement and versatile uses of Information and Communication Technologies (ICT) (Luan et al., 2020; Sugimoto et al., 2017). Online conferences are one of the applications of technology advances, which can facilitate continuing professional development for geographically dispersed participants (Moore et al., 2016). However, the norm or the long-kept custom of professional meetings have largely remained its face-to-face tradition until there are inevitable reasons to change the routine practices. Notably, the pandemic of the Coronavirus Disease 2019 (COVID-19) has propelled the academic community to reconsider its style of the convention in order to avoid spreading or contracting the disease. Equally important is to sustain the development of the community's social and intellectual interaction (Wu, et al., 2020). Amid the uncertainty of the disease outbreak, orders to enforcing social distancing, stay-at-home, or shelter-in-place have become an international trend (e.g., Mervosh et al., 2020). Features such as live streaming, interactivity (e.g., raise a hand, text/voice chatting), and productivity (screen sharing, annotation, co-editing) have greatly improved the quality of human communication. Thus, turning face-to-face conferences into online or virtual conferences may be what the current technological tools (e.g., Microsoft Teams, ZOOM, WebEx, Google Meet, and Jitsi Meet) can do to contain the outbreak and to maintain the prosperity of the research community.

Nevertheless, there was a scarcity of studies investigating participants' behavior in professional face-to-face conferences (Jacobs & McFarlane, 2005). Even less researched was how participants adapt and react to the virtual forms of academic conferences (Moore et al., 2016). Notably, conferences in any form are an indispensable part in the professional development for people in the academia. In traditional face-to-face conferences, participants' demographic differences such as their gender and academic ranks significantly influence their perception about the conference as well as their behavior/ decision whether to stay or leave their academic career (e.g., Biggs et al., 2018; Látková et al., 2009). Therefore, it is worth investigating how these differences are associated with their virtual conference participation experiences and engagement. For the gender issue (e.g., Lee & Wu, 2013; Wu, 2014; Wu & Cheng, 2019), gender inequity was commonly reported in academic conferences, with female participants reporting more easily affected by perceived gender inequity in the conference (Biggs et al., 2018). On the other hand, conferences are great venues for student participants and faculty members/researchers to establish linkage and share expertise, experience, and innovation (Mata et al., 2010). However, the costly expenses of travel, accommodation, and registration may pose great challenges for early-career researchers to attend academic conferences (Henderson, 2015). Thus, investigating the association of participants' demographic characteristics with their perceptions and engagement in the virtual conference can

contribute to the limited literature in virtual academic conferences and shed light on establishing a positive virtual environment to promote the professional academic development.

The study examines participants' behavior patterns in a one-day virtual conference in e-Learning via their anonymous log files (Wu et al., 2021). Their onymous reflection upon their perception, competence, and engagement regarding this virtual conference are also investigated via questionnaires. The virtual conference consists of several online events and meetings, including the opening and closing ceremonies, two keynote speeches, and five parallel meeting rooms consisting of 15 oral presentation sessions (three sessions in each meeting room). Based on the theory of self-efficacy (Bandura, 1993), we explore how participants' mastery experience (defined as satisfaction with previous successful experience) is associated with their competence in the virtual conference, which in turn is related to their engagement in the virtual conference. By studying the hypothesized association, we intend to inform future virtual conference organizers of the factors that are pivotal to attendee's participation experience and enhance the development of virtual scholarship. Thus, the purpose of this study was threefold. First, we intended to analyze participants' unstructured trace data from the online conference platform to understand the general state and the variability of their participation or presence in the virtual conference. Second, we examined participants' mastery experience, competence, and engagement in the online conference by analyzing their structured responses via the post-conference survey. Third, we aimed to provide suggestions and implications to enhance the scholarship in the technology-enhanced environment, with triangulating sources of evidence from the analytics of unstructured and structured participation data (Wu, 2020). Therefore, the research questions for this study are

- RQ1: What are the attendees' participatory behaviors in the virtual conference, as reflected by their anonymous trace data on the conference platform?
- RQ2: What is the state of participants' mastery experience, competence, and engagement in the virtual conference? Will participants' gender and their academic rank have a differential effect on their perceived mastery experience, competence, and engagement in the virtual academic conference?
- RQ3: What is the association among participants' mastery experience, competence, and engagement in the virtual conference?

## 2. Literature review

### 2.1. Human behavior in virtual academic or professional development activities

The capability of the technology enables the analysis and monitoring of participants' behavior as well as co-constructing knowledge in the virtual conference. For example, in a virtual conference, Moore et al. (2016) showed that the percentage of participants who contributed to the text chat (active) ranged from 46% to 92% across six webinar sessions with an average active rate of 59.5%, which was regarded as significant participants' contribution. Moreover, the discourse types in the Webinars can be categorized into interpersonal (20%), evaluative (12%), technical (11%), procedural (8.5), or content (52%) based on the analysis of the text chats (Moore et al., 2016). Instead of moving face-to-face conferences online, some conferences used social media as a means for participating online and examined the effect of backchanneling on participants' behavior in the professional conferences (Kimmons & Veletsianos, 2016). Specifically, the expansion of technology-enhanced mobile and participatory online environments allows participants to have real-time texting or chatting when a presentation or event is ongoing, which is called "backchannelling" (Kellogg et al., 2006). Recent research reported that the social media-supported backchanneling alongside the main conference could enhance academic learning through expanded participation in conference programs and provide opportunities for more researchers to join the professional community (Greenhow et al., 2019). Early findings also revealed, "backchannel technologies empower members of the audience to communicate among themselves, and to investigate all kinds of related information and make these public" (p. 328, Jacobs & McFarlane, 2005). The study results support that these technological tools may promote user interconnections and decentralize the conference to uphold a co-constructed value in social scholarship in academia (Greenhow & Gleason, 2014). Like Webinars or backchanneling, virtual conferences can promote attendees' mutual communication via text chatting or direct audio and video streaming. However, they maintain the essential formats of their face-to-face version by moving their opening/closing ceremony, keynote speeches, parallel, or unparalleled oral presentations on the virtual space. The computer-mediated virtual conferences may exhibit similarities and differences as compared to face-to-face conferences. Thus, we would like to investigate how attendees adapt and react to the new style of conference presentation and learning to inform the design and organization of future virtual conferences, especially in a time of pandemic.

### 2.2. Attendees' perceptions, competence, and engagement

Ground on the theory of self-efficacy (Bandura, 1993), this study investigated attendees' perceptions, competence, and engagement in the virtual academic conference. Self-efficacy is key to one's self-regulation of motivation and is associated with engagement in the task as well as task performance (Bandura, 1977). Specifically, self-efficacy is the competence belief of what people think they can do. People may develop their self-efficacy based on four sources: mastery experiences, vicarious experiences, verbal persuasion, and emotional and physiological states, among which mastery experience is posited as the most potent source (Bandura, 1997). Empirical studies provided evidence to demonstrate the interrelationship among mastery experiences, self-efficacy, and task engagement. For example, mastery experiences (operationalized as a sense of satisfaction with one's past teaching success) were positively related with teachers' self-efficacy beliefs (Lee et al., 2019); moreover, prior teaching success weighed more for novice teachers' self-efficacy due to their limited mastery experiences compared with the experienced teachers (Tschannen-Moran & Hoy, 2007). Additionally, in a sample of 595 primary and secondary school teachers, teachers' self-efficacy was positively associated with changes in their work engagement (Granziera & Perera, 2019). Moreover, surveying 252 undergraduate and graduate students about their sources of Internet self-efficacy, Chuang, Lin, and Tsai (2015) showed that prior successful experiences of Internet use played an essential role in participants' Internet self-efficacy. Researchers also revealed that general Internet self-efficacy predicted more informational Internet activities, especially among non-experts in technology (Jokisch et al., 2020).

Based on the relevant studies about mastery experiences, self-efficacy, and engagement, we postulated that attendees' mastery experiences would be correlated with their perceived competence in virtual conferences, which would, in turn, predict their engagement in the virtual academic conference.

### 2.3. Gender and academic rank differences in the perception of academic conference participation

Professional conferences are great venues for scholars to share their research, obtain the latest information/developmental trend in their field, and communicate with fellow scholars within the same or across different research fields. However, gender issues exist in the presentation and participation in academic conferences. Jones et al. (2014) reported that women consistently presented less time than their counterparts regardless of their academic rank in a conference that had a 1:1 gender ratio. Women also asked fewer questions than men (1:1.8) in a scientific conference that promotes a clear code of conduct in prohibiting any form of discrimination (Hinsley et al., 2017). The perception of sexism or gender inequality in conference participation may have a detrimental effect on women's career development. Mainly, Biggs, Hawley, and Biernat (2018) showed that women who felt sexism and silenced at the conference would increase their intention to leave academic careers while men who perceived sexism would increase their intention to leave that specific conference but not the academia. In this study, we would investigate the gender differences in attendees' mastery experiences, competence, and engagement in the virtual conference.

Moreover, membership and participation in academic conferences are an essential means of professional development for both student and professional participants (Mata et al., 2010). In particular, students reported that interacting with professors or researchers was goal attainment in their academic development (Cheng et al., 2019; Látková et al., 2009). Moreover, participating in academic conferences can generate a research culture among students (Hall, 2015) and have positive impacts on studies or career, presentation skills, personal confidence, as well as research skills and perspectives (Little, 2020). However, it is not known how differences in academic rank will impact participation in virtual academic conferences. We would examine individual differences in academic ranks regarding mastery experiences, competence, and engagement in the virtual conference.

## 3. Method

### 3.1. Data source

The current study included two sources of attendees' data in a virtual conference of e-Learning in Taiwan (Taiwan e-Learning Forum of year 2000, TWELF2020), namely the unstructured behavioral data collected from the Zoom conferencing platform and the structured assessment of attendees' virtual conference experience via the post-conference questionnaire. For the past 14 years, the conference was held annually in late March as face-

to-face conferences. However, it was transformed into a virtual conference due to the pandemic of COVID-19 in 2020.

The post-conference survey link was sent to 150 people who registered the conference, of which 106 provided their full response to the questionnaire (response rate = 70.67%) because all the question items were set as required. 72.2% of respondents have experience in attending the previous face-to-face meetings. 44.3% of the respondents were female, and 55.7% male. Among the respondents, their registration status can be categorized into session chair (9.4%), presenter (72.6%), and participants (17.9%). Their academic rank can be classified into student participants (e.g., master and doctoral students: 47.2%) or professional participants (e.g., researchers, scientists, faculty members: 52.8%).

### 3.2. Measures

#### *3.2.1. Unstructured data of log traces*

The unstructured data was collected from the log or traces of participants logging in the Zoom conference platform. Room A was the main virtual conference venue that hosted three activities in the morning: the opening ceremony and two keynote speeches. In the afternoon, three consecutive parallel sessions (i.e., Oral Paper session 1~3) were hosted in five parallel virtual meeting rooms (i.e., Room A, B, C, D, and E). We can only get the usage data from the first three rooms (i.e., Room A, B, and C) across three sessions of presentation due to the limited reporting features in the free subscription licenses. The closing ceremony was then held in Room A as the last event of the conference. We analyzed unstructured data on the conference-based and session-based units. The conference-based behaviors included three indices: (1) the total number of log-ins, (2) the total number of participants (calculated as the sum of unique IDs), (3) the instant maximum number of participants across sessions. The session-based behaviors consisted of nine indices: (1) average number of participants in each session, (2) instant maximum number of participants in each session, (3) session duration, (4) average participation duration, (5) average percentages of participation, (6) the number of dedicated participants (defined as the number of participants who completed a session for at least 70% of the time), (7) audience rating: an index score considering proportion of viewing time in the time period of a specific session over the total number of conference participants in the given time as suggested by Meyer and Hyndman (2006), (8) popularity rating: percentage of dedicated participants in each session (i.e., # of dedicated participants over the number of participants in each session), (9) retention rate (i.e., the ratio of common IDs stays at same room for the next session), and (10) the average number of switches in parallel sessions (i.e., the times that a participant leaves a room and joins another room in parallel sessions).

#### *3.2.1. Structured data of psychological measurement*

The structured data was collected using the researcher-developed questionnaire. The questionnaire was comprised of two parts. Part I collected participants' demographic information, such as their gender, age, and academic rank. Part II asked their mastery experience, competence, engagement, and general perception of the conference.

Mastery experience was adapted from Tschannen-Moran and Hoy (2007) and operationalized as participants' satisfaction in their experiences of participating in keynote speeches, oral presentations, and overall conference (3 items). Responses were rated on a 5-point Likert scale, with 1 *extremely disagree* to 5 *extremely agree*. Sample item is "I am satisfied with my overall experience in this virtual conference." The standardized factor loadings ranged from .62 to .89 of this just-identified Confirmatory Factor Analysis (CFA) model (Wu et al., 2018). Internal consistency was .81, with AVE = .82 & CR = .62.

Competence in the virtual conference was developed by adapting Harter's perceived competence scale (1982). The developed scale had three dimensions: social interaction competence (3 items), academic competence (3 items), and ICT use competence (4 items). Social interaction competence reflected participants' perceived competence to interact with new or familiar peers in academia. Academic competence assessed their perceived competence in presenting, receiving, and sharing academic findings. ICT competence demonstrated their perceived competence in using technology to prepare, join, or switch between different presentations or media. Sample items included "I am certain I can make new friends in the virtual conference (social interaction)," "I believe I can obtain the latest research development or trends in the virtual conference (academic)," "I am

confident that I can switch between rooms and attend more parallel sessions in the virtual conference (ICT)." Responses were rated on a 5-point Likert scale, with 1 *extremely disagree* and 5 *extremely agree*.

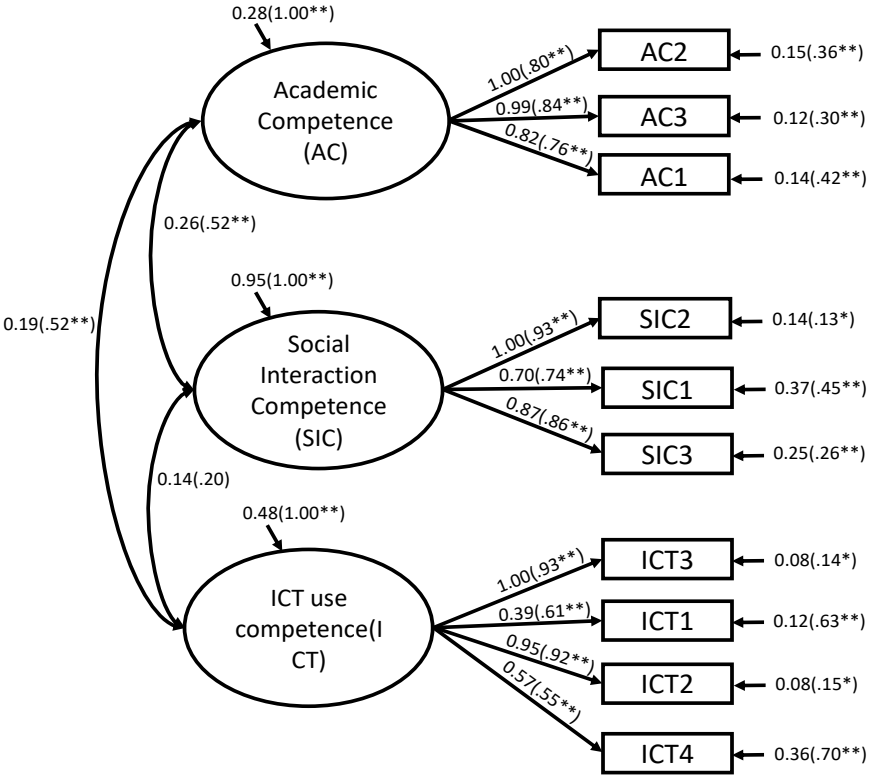


*Figure 1*. Three-factor Confirmatory Factor Analysis (CFA) for Competence in Virtual Conference Questionnaire (*Note.* Model-fit information: $\chi^2 = 39.75$, $df = 32$, $p = .16$, $CFI = .98$, $TLI = .98$, $RMSEA = .05$, $SRMR = .06$. The values in parentheses were standardized coefficients. $^{*}p < .05$; $^{**}p < .01$)

As shown in Figure 1, a three-factor CFA was fitted to the competence belief data. The model indicated adequate fit to the data, $\chi^2 = 39.75$, $df = 32$, $p = .16$, $CFI = .98$, $TLI = .98$, $RMSEA = .05$, $SRMR = .06$. The standardized factor loadings ranged from .55 to .93. Internal consistency was .84 for academic competence, .88 for social interaction competence, and .83 for ICT use competence. The overall internal consistency was .84. Average variance extracted (AVE) ranged from .64 to .74 and composite reliabilities (CR) ranged from .84 to .89. The factor scores of the three constructs were saved as indicators for the latent factor of the virtual conference competence in order to test the structural relationship among mastery experience, competence, and engagement.

Participants' engagement was a behavioral measure quantified by the number of sessions they attended. Finally, we surveyed the general perception of the virtual conference. They responded to their preference in attending virtual or face-to-face conferences in the future and to their perceived engagement level of this virtual conference (i.e., more engaged, equally engaged, or less engaged).

### 3.3. Data analysis

We computed descriptive statistics to understand participants' behavior and perception in attending the virtual conference on the R platform (The R Core Team, 2020). Ten virtual conference behavior indicators from unstructured log traces were calculated from the author-built R package. As for the structured responses from questionnaires, we utilized lavaan package (Rosseel et al., 2019) with Full Information Maximum Likelihood estimation (FIML, Mehta & Neale, 2005) to perform CFA and SEM analyses (Wu et al., 2017). All univariate normality measures (kurtosis and skewness) were within ±6. We also performed the visual examination of Q-Q plots, which exhibited the relation between the expected value of normal distribution and the observed value (Hair et al., 2010; Kline, 2010). The measures and Q-Q plots suggested that the normality assumption held for the response variables. However, the multivariate normality measures (e.g., Mardia test) was statistically significant, which was commonly seen when the sample size was greater than 106 with more measured variables (Cain et al., 2017). Considering the possible data non-normality (Wu et al., 2014), we addressed the issue by

applying the MLR procedure with Satorra-Bentler rescaled chi-square ($\chi^2$) model fit test statistic and corrected fit indices (i.e., *CFI, TLI, RMSEA,* and *SRMR*) to evaluate the model goodness-of-fit (Hu & Bentler, 1999; Wu & Kwok, 2012). Besides, in order for the observed scores to be compared between groups on the same standing, we tested the measurement invariance of the competence scales in a series of models, including configural, metric, and scalar invariances across groups (Millsap, 2011). The instrument must demonstrate scalar invariance to reach valid conclusions regarding observed group differences (Wu & Cheng, 2019). Comparative models were regarded as statistically equivalent if $\Delta CFI \leq .02$(Cheung & Rensvold, 2002), $\Delta TLI \leq .05$ (Little, 1997), $\Delta RMSEA \leq .015$, and $\Delta SRMR \leq .01$(Wu & Hughes, 2015). Moreover, if the majority of criteria satisfy the suggested thresholds, measurement invariance assumptions are established (Wu & Hughes, 2015). Additionally, we tested the structural relationship among attendees' mastery experience, perceived competence, and engagement in a mediation analysis within the structural equation modeling framework (Chou & Lee, 2017; Wu, 2017).

## 4. Result

### 4.1. Descriptive statistics and correlations of unstructured and structured indicators

For the entire conference, there were a total of 1700 times of log-ins in record with 602 unique log-in IDs. Participants' log traces in the one-day virtual conference were visualized as a Gantt diagram in Figure 2.

Gantt diagram visualizes participants' traces regarding the conference rooms they visited over time. Each row indicates the participating pattern per attendee. For example, participant ID363, who switched conference rooms frequently, stayed in Room C from 14:20~14:30, in Room B from 14:30~14:45, then went back to Room C for a few minutes, and log out and return to Room A before he left the conference. For the three oral presentation sessions, more frequent changes in colors within the same session indicated more switches among presentation rooms.

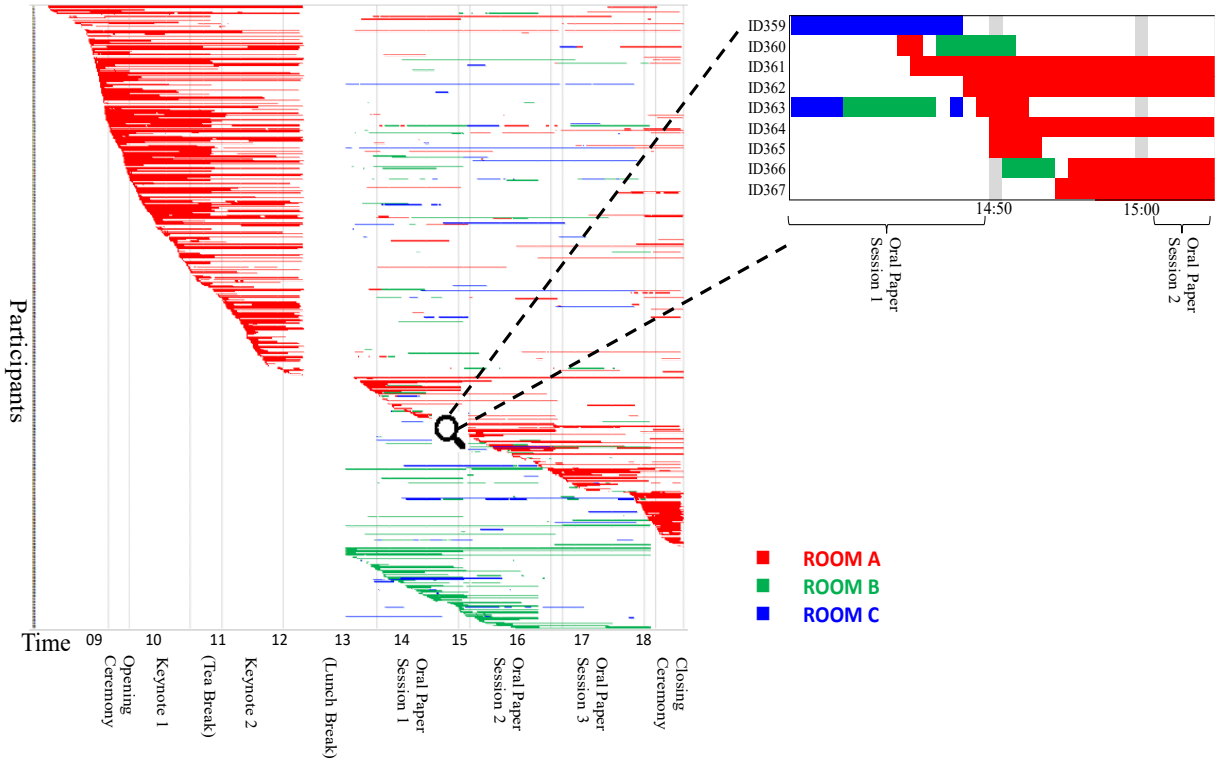


*Figure 2*. The Gantt diagram of participants' log traces in the one-day virtual conference. *Note.* Participants' traces were sorted in the order of starting time. Colors indicated different rooms that participants entered (Red: Room A, Green: Room B & Blue: Room C)

Figure 3 depicted the average (orange line) and instant (black line) number of participants from 8 am to 7 pm during the day of the conference. The average number of participants ranged from 75 to 130. The curvy black line reflected that the instant number of participants gradually increased before the start of each activity or

session and dropped only a little bit during the session break, except for the lunch break. The instant maximum number of participants was 152 during the switch between the two keynote speeches.

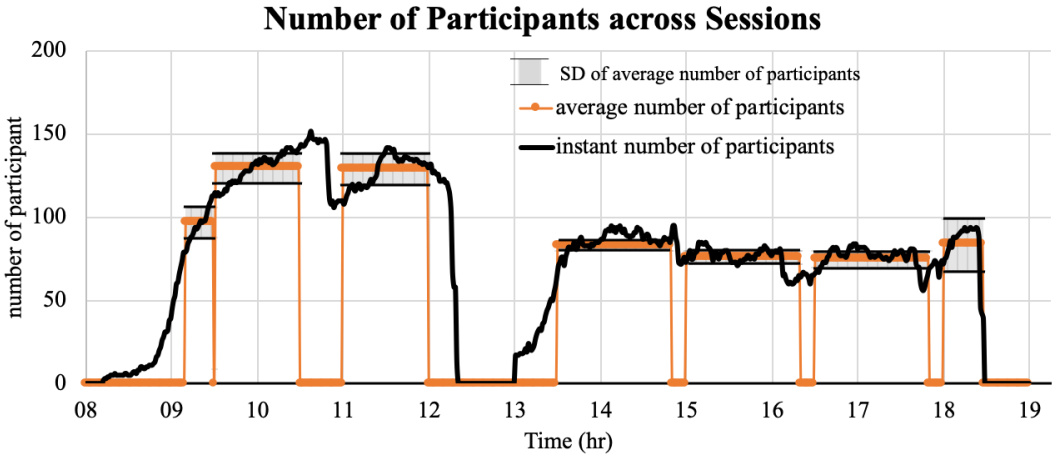


*Figure 3.* The average (solid orange line) and instant (black curve) number of participants from 8am to 7pm during one day conference. A gray area indicates the standard deviation of the number of participants in each session.

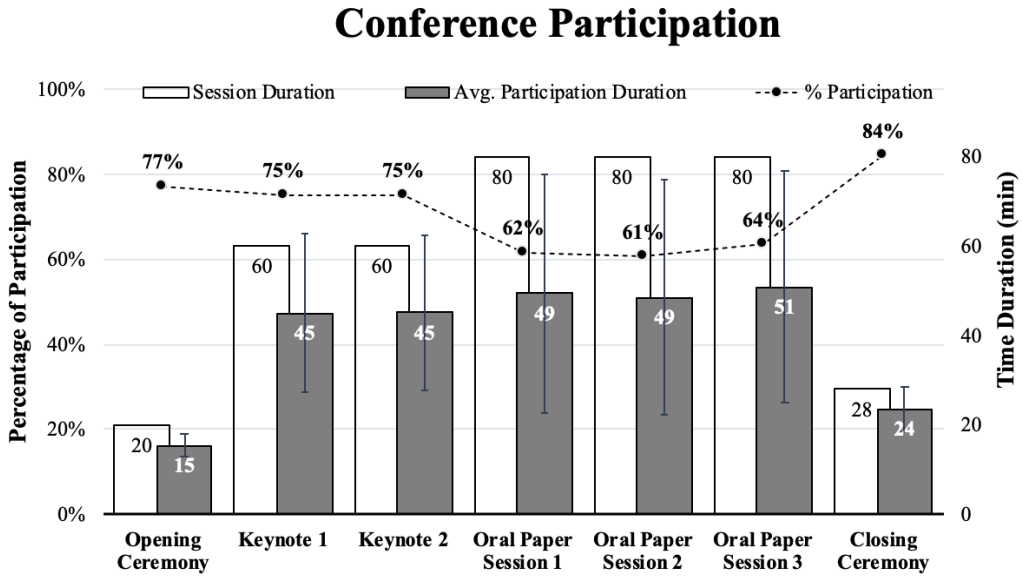


*Figure 4.* The session duration (white bar), average participation duration (gray bar with margin of error whisker), and average percentages of participation in each session

For the session-based behaviors, Figure 4 illustrated that attendees' average participation duration ranged from 15 to 51 mins within each activity or session. Proportional to session duration, average percentages of participation ranged from 61% to 84%. As shown in Figure 5, the number of participants who completed the session more than 70% of the time (dedicated users) ranged from 56 to 108. Thus, there was an audience rating of 9% to 18% of dedicated participants out of the total number of conference participants. Within each session, the average number of participants ranged from 75 to 130.

In terms of the popularity rating (percentage of dedicated participants in each session) as shown in Figure 6, the closing ceremony, the opening ceremony, and the two keynote speeches had the highest percentage of engaged participants, 87%, 86%, 83%, and 80% respectively. The average number of switches between parallel sessions ranged from 1 to 1.6 times. As for retention rate (i.e., the ratio of common IDs stays at the same room for the next session), keynote speech 1, opening ceremony, and presentation 3 had the highest retention rates, 95%, 92%, and 64%, respectively.

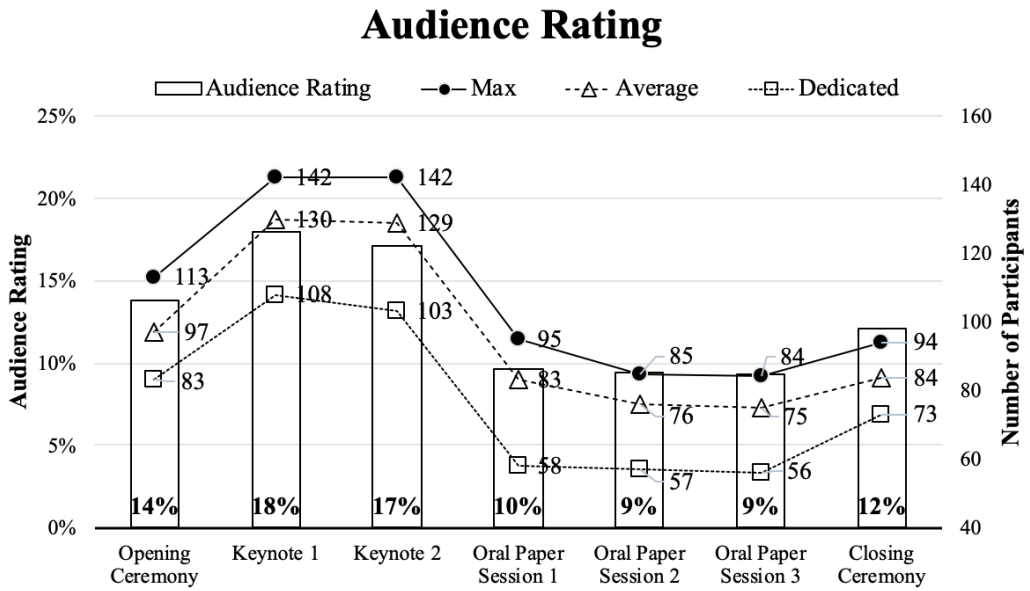


*Figure 5.* Audience rating (white bar with bold font) and the number of dedicated participants (# of participants who completed the session for more than 70% of the session duration) in each session, including the max and average number of participants

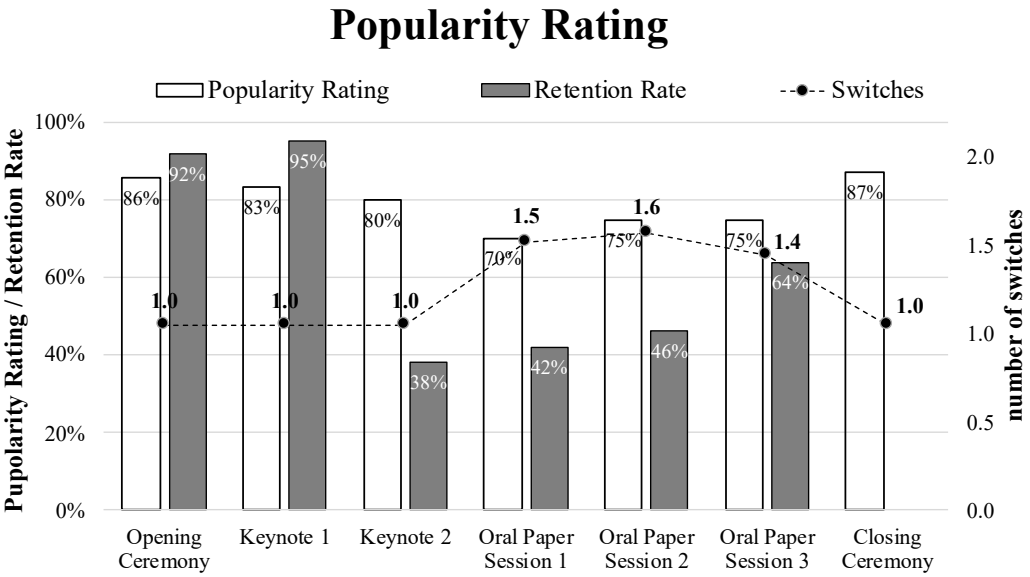


*Figure 6.* Popularity rating (white bar), retention rate (gray bar), and average number of switches (bold font) in each session

Descriptive statistics and correlations of structure survey responses were tabulated in Table 1. Attendees' average competence in attending the virtual conference was highest for ICT use competence, followed by academic competence, and social interaction competence ($M$ = 4.58, 4.44, and 3.87, respectively). They exhibited high mastery experience in participating in the virtual conference ($M$ = 4.68) and attended 4.10 meeting sessions on average. Mastery experience was positively related to all aspects of competences ($r$ = .28~.60, $p$ < .05). Academic competence was positively associated with social interaction competence and ICT use competence ($r$ = .47 and .50, $p$ < .05). Scores of ICT use competence, the overall competence, and mastery experience were positively correlated with the number of sessions participated ($r$ = .28, .24, and .37, $p$ < .05). 56.6% of the attendees reported their preference toward virtual conferences, while 43.4% reported favoring face-to-face conferences. Though more than half of the participants expressed that they were more engaged (11.3%) or equally engaged (45.3%) in the virtual conference compared with face-to-face conferences, 43.4% of respondents perceived virtual conferences to be less engaging.

*Table 1.* Descriptive statistics and correlations of structured responses

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1. Social interaction competence | -- | | | | | |
| 2. Academic competence | .47* | -- | | | | |
| 3. ICT use competence | .19* | .50** | -- | | | |
| 4. Total competence | .78* | .80** | .71** | -- | | |
| 5. Mastery Experience | .28* | .60** | .48** | .56** | -- | |
| 6. Engagement: # of sessions participated | .10* | .20 | .28* | .24* | .37* | -- |
| *M* | 3.79 | 4.44 | 4.58 | 4.30 | 4.68 | 4.09 |
| *SD* | 0.89 | 0.54 | 0.55 | 0.49 | 0.42 | 2.80 |
| Kurtosis | -0.25 | -0.75 | 0.93 | -0.38 | 0.10 | -0.17 |
| Skewness | -0.37 | -0.47 | -1.25 | -0.36 | -1.07 | 0.63 |

*Note.* $^{*}p < .05$; $^{**}p < .01$.

### 4.2. The measurement invariance tests

In order to compare the scale scores of competences in virtual conferences between groups, consecutive measurement invariance analyses were conducted. The configural assumption was first conducted to test the equality of the number of factors and the number of non-zero factor loadings across gender and academic rank. The results indicated the configural assumptions held for both gender and academic rank ($\chi^2 = 116.73$, $df = 64$ with $p < .01$, $CFI = .90$, $TLI = .85$ and $SRMR = .08$ for gender; $\chi^2 = 100.82$, $df = 64$ with $p < .01$, $CFI = .93$, $TLI = .90$ and $SRMR = .09$ for academic rank). Next, metric invariance was tested by further fixing the factor loadings equal across groups and was supported for both gender and academic status (Chi-square differential test $\Delta\chi^2 = 3.27$, $\Delta df = 7$ with $p = .86$, $\Delta CFI = .013$, $\Delta TLI = .023$ & $\Delta SRMR = .012$ for gender; $\Delta\chi^2 = 7.79$, $\Delta df = 7$ with $p = .35$, $\Delta CFI = -.002$, $\Delta TLI = .008$ $\Delta SRMR = .016$ for academic rank). Then, scalar invariance was tested by further fixing the item intercepts equal across groups and was also supported for both gender and academic status ($\Delta\chi^2 = 5.56$, $\Delta df = 7$ with $p = .59$, $\Delta CFI = .002$, $\Delta TLI = .015$ & $\Delta SRMR = .002$ for gender; $\Delta\chi^2 = 6.31$, $\Delta df = 7$ with $p = .50$, $\Delta CFI = .001$, $\Delta TLI = .010$ & $\Delta SRMR = .003$ for academic rank). The results of the MI analyses demonstrated that the measurement structure of competence beliefs was invariant across gender and academic ranks and can be directly compared with observed scores (Meredith, 1993).

### 4.3. Results of repeated measure ANOVA, the independent sample t-tests, and chi-squared test of independence

Due to high correlation coefficients among the competence measures, we conducted repeated-measures ANOVA to test if participants' three means of competence beliefs were equal. The Mauchly's test for sphericity was violated, W = .67, $p < .05$; thus, we adopted the Greenhouse-Geisser correction, $F = 48.96$, $p < .05$. Post-hoc test using Tukey contrast showed that participants' academic competence and ICT use competence were significantly higher than their social interaction competence ($\Delta M_{\text{Academic-Social}} = 0.65$ & $\Delta M_{\text{ICT use-Social}} = 0.79$, $p < .05$).

*Table 2*. The independent *t*-test on competence in virtual conference between gender

| | Gender | *N* | *M* | *SD* | *t* | *p* |
|---|---|---|---|---|---|---|
| Social interaction competence | Female | 35 | 3.75 | 0.74 | -.32 | .75 |
| | Male | 48 | 3.81 | 0.98 | | |
| Academic competence | Female | 35 | 4.28 | 0.51 | -2.41 ** | .02 |
| | Male | 48 | 4.56 | 0.54 | | |
| ICT use competence | Female | 35 | 4.60 | 0.53 | .22 | .82 |
| | Male | 48 | 4.57 | 0.56 | | |
| Total competence | Female | 35 | 4.25 | 0.48 | -.84 | .41 |
| | Male | 48 | 4.34 | 0.50 | | |
| Mastery Experience | Female | 47 | 4.62 | 0.45 | -1.24 | .22 |
| | Male | 59 | 4.72 | 0.40 | | |
| # of sessions participated | Female | 47 | 3.77 | 2.49 | -1.08 | .28 |
| | Male | 59 | 4.36 | 3.02 | | |

*Note.* Tukey contrast post-hoc test was used. $^{*}p < .05$; $^{**}p < .01$.

The results of independent sample *t*-tests were shown in Table 2 and Table 3 for gender and academic rank. We observed a gender difference in academic competence, where women exhibited lower academic competence than men ($M_{female}$ = 4.28, $M_{male}$ = 4.56, $t$ = -2.41, $p$ = .02). Compared with student participants, professional participants had higher mastery experience ($M_{student}$ = 4.56, $M_{professional}$ = 4.78, $t$ = -2.79, $p$ = .01) and participated in more sessions ($M_{student}$ = 3.34, $M_{professional}$ = 4.77, $t$ = -2.70, $p$ < .01) in the virtual conference.

*Table 3.* The independent *t*-test on competence in virtual conference between academic rank

| | Academic rank | *N* | *M* | *SD* | *t* | | *p* |
|---|---|---|---|---|---|---|---|
| Social interaction competence | Student | 41 | 3.88 | 0.82 | -.92 | | .36 |
| | Professional | 42 | 3.70 | 0.95 | | | |
| Academic competence | Student | 41 | 4.33 | 0.60 | -1.90 | | .06 |
| | Professional | 42 | 4.55 | 0.46 | | | |
| ICT use competence | Student | 41 | 4.69 | 0.49 | 1.74 | | .09 |
| | Professional | 42 | 4.48 | 0.59 | | | |
| Total competence | Student | 41 | 4.34 | 0.52 | -.64 | | .52 |
| | Professional | 42 | 4.27 | 0.46 | | | |
| Mastery Experience | Student | 50 | 4.56 | 0.47 | -2.79 | ** | .01 |
| | Professional | 56 | 4.78 | 0.34 | | | |
| # of sessions participated | Student | 50 | 3.34 | 2.59 | -2.70 | ** | < .01 |
| | Professional | 56 | 4.77 | 2.83 | | | |

*Note*. Tukey contrast post-hoc test was used. $^{*}p < .05$; $^{**}p < .01$.

We tested the association of gender and professional rank difference on participants' preference toward virtual or face-to-face conferences and their perceived engagement with the chi-square test. The results were tabulated in Table 4 and Table 5. Gender did not exhibit an association with the preference ($\chi^2$ = .30, $df$ = 1, $p$ = .58) but academic rank did ($\chi^2$ = 9.13, $df$ = 1, $p$ < .01). Student participants preferred participating in virtual conferences while professional participants preferred participating in face-to-face conferences (adjusted standardized residual = -3.0, respectively). As for perceived engagement level in the virtual conference, we found disproportionately more counts of women reported being more engaged in the virtual conference, while disproportionately fewer counts of men were also found reporting more engaged in the virtual conference ($\chi^2$ = 8.55, $df$ = 2, $p$ = .01, adjusted standardized residual = ±2.9). Similarly, we found more counts of professional participants reported being more engaged in the virtual conference than student participants (adjusted standardized residual = ±2.9); besides, more observed student participants than professional participants reported equally engaged (adjusted standardized residual = ±2.1) in the virtual conference compared with the face-to-face conference (Pearson $\chi^2$ = 9.71, $df$ = 2, $p$ < .01).

*Table 3.* Chi-square test of conference preference between demographic variables

| Conference preference | | Gender | | $\chi^2(1)$ |
|---|---|---|---|---|
| | | Female | Male | |
| Virtual | Count | 28 | 32 | .30 |
| | Expected Count | 26.6 | 33.4 | |
| | Adj. Standardized Residual | 0.6 | -0.6 | |
| Face-to-face | Count | 19 | 27 | |
| | Expected Count | 20.4 | 25.6 | |
| | Adj. Standardized Residual | -0.6 | 0.6 | |
| | | Academic rank | | $\chi^2(1)$ |
| | | Professional | Student | |
| Virtual | Count | 24 | 36 | 9.13** |
| | Expected Count | 31.7 | 28.3 | |
| | Adj. Standardized Residual | 3.0 | -3.0 | |
| Face-to-face | Count | 32 | 14 | |
| | Expected Count | 24.3 | 21.7 | |
| | Adj. Standardized Residual | -3.0 | 3.0 | |

*Note*. Pearson $\chi^2$ test statistics with degrees of freedom in paratheses was reported. $^{*}p < .05$; $^{**}p < .01$.

*Table 4.* Chi-square test of perceive engagement between demographic

| Perceived engagement | | Gender | | $\chi^2(2)$ |
|---|---|---|---|---|
| | | Female | Male | |
| More engaged | Count | 10 | 2 | 8.55** |
| | Expected Count | 5.3 | 6.7 | |
| | Adj. Standardized Residual | 2.9 | -2.9 | |
| Equally engaged | Count | 20 | 28 | |
| | Expected Count | 21.3 | 26.7 | |
| | Adj. Standardized Residual | -0.5 | 0.5 | |
| Less engaged | Count | 17 | 29 | |
| | Expected Count | 20.4 | 25.6 | |
| | Adj. Standardized Residual | -1.3 | 1.3 | |
| | | Academic rank | | $\chi^2(2)$ |
| | | Professional | Student | |
| More engaged | Count | 11 | 1 | 9.71** |
| | Expected Count | 6.3 | 5.7 | |
| | Standardized Residual | 2.9 | -2.9 | |
| Equally engaged | Count | 20 | 28 | |
| | Expected Count | 25.4 | 22.6 | |
| | Standardized Residual | -2.1 | 2.1 | |
| Less engaged | Count | 25 | 21 | |
| | Expected Count | 24.3 | 21.7 | |
| | Standardized Residual | 0.3 | -0.3 | |

*Note*. Pearson $\chi^2$ test statistics with degrees of freedom in paratheses was reported. *$p < .05$; **$p < .01$.

### 4.4. Association among mastery experience, competence, and engagement

In order to test if participants' virtual conference experience is in line with the self-efficacy theory (Bandura, 1993), a structural model was fitted among mastery experience, competence, and engagement in the virtual conference, where competence mediated the association between mastery experience and engagement (i.e., the number of Zoom meetings attended) (Wu & Peng, 2017).

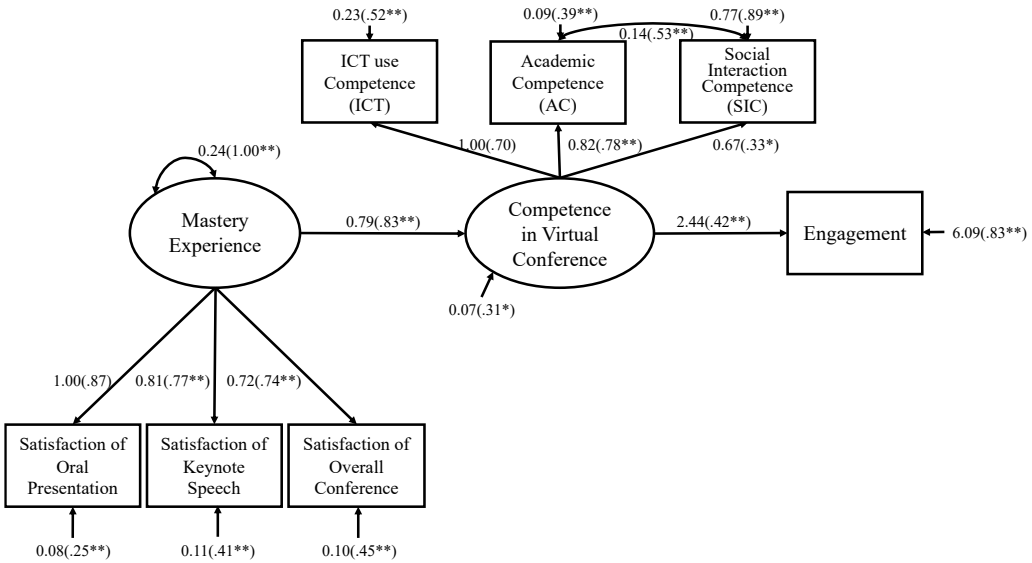


*Figure 7.* The structural model among mastery experience, competence, and engagement in the virtual conference. *Note.* Model-Fit Information: $\chi^2 = 16.24$, $df = 12$, $p = .18$, $CFI = .98$, $TLI = .97$, $RMSEA = .07$, $SRMR = .05$. *$p < .05$; **$p < .01$.

The hypothesized model had an adequate fit to the data, $\chi^2 = 16.24$, $df = 12$, $p = .18$, $CFI = .98$, $TLI = .97$, $RMSEA = .07$, $SRMR = .05$). The analysis results were illustrated in Figure 7. As expected, mastery experience positively predicted competence of virtual conference participation ($\beta_{mastery \rightarrow competence} = .83$, $p < .01$), which in turn was associated with more Zoom sessions attended ($\beta_{competence \rightarrow engagement} = .42$, $p < .01$). The standardized indirect

association of mastery experience with engagement was .35 via competence of virtual conference participation ($\beta_{\text{mastery}\rightarrow\text{competence}\rightarrow\text{engagement}}$ = .35, $SE_{\text{Sobel test}}$ = .57, $t$ = 3.35, $p$ < .01). The variance explained $R^2$ was 69% for competence and 17% for engagement.

## 5. Discussion

This study adds to a burgeoning, yet a scarce body of literature that investigates virtual conference participation behavior (e.g., Moore et al., 2016). With the more frequent implementation of virtual conferences due to the convenience of use or to the avoidance of disease outbreak, the growing research may strengthen the development of a more comprehensive corpus of an empirical base for understanding virtual conference experience and behavior. The overarching goal of our research is to answer the three questions: (1) To what extent do attendees participate in the virtual conference as reflected by their trace data on the conference platform? (2) What are the overall and individual difference in participants' mastery experience, competence, and engagement? (3) What is the association among attendees' mastery experience, competence, and engagement in the virtual conference? In the age of pandemic, social distancing has become a norm. More professional conferences will be held in the virtual form. Besides virtual conferences' advantages in budgets and benefits to the environment (e.g., less travel and less pollution), this study used a data driven approach to explore attendees' participation pattern and their perceptions about the participation experiences. Findings were discussed in the terms of three following themes: extended and deepened participation, individual differences in virtual conference participation, and the association among virtual conference perception, competence, and engagement.

### 5.1. Extended and deepened participation experiences in the virtual conference

Analyzing the participation behavior via the trace data on the platform, we discovered extended participation for learning in the virtual conference. Specifically, due to the pandemic of COVID-19, this e-Learning conference was transformed into a virtual one and was open to people around the world with access to the ZOOM meeting links. As a result, there were 150 registered participants on the official record, but we obtained 602 unique IDs with a total of 1700 times of log-ins. It was apparent that the open-access of the virtual conference increased the possibilities of participation from those who were not physically present in the meeting, achieving an effect similar to the backchanneling alongside a face-to-face conference (Greenhow et al., 2019). Moreover, unlike backchanneling where participants twitted mainly to reference the meeting or to promote scholarship and networking (Greenhow et al., 2019), we found that attending the virtual conference can enhance attendees' conference participation experience by allowing them to have full access to the meeting regardless of the physical constraints. For example, our findings revealed that the audience rating for the conference sessions ranged from 9% to 18%, suggesting that there were 56 to 108 dedicated participants in each session on average. Besides, the popularity rating also showed that there were more than 80% dedicated participants in several programs, such as opening ceremony, closing ceremony, and keynote speeches. Our retention rate analyses further indicated that programs such as opening ceremony and Keynote speech have successfully retained more than 90% of attendees who participated in the current program to join the next program. Research was scare in studying the retention rate in conference sessions. However, in the television viewing market, Jardine and Romaniuk (2009) reported a retention rate around 50-60% for primetime television viewing in Australia, which constitutes the majority of the audience size of the next program. Particularly, the quality of the program was the significant determinant of the lead-in audience retention (retaining audience from the previous program) (Jardine et al., 2016). The opening ceremony lasted for 15 minutes, followed immediately by the two keynote speeches (45 min each). Thus, the high retention rates were mostly due to the two keynote speeches, which were usually the most important talks delivered in academic meetings and featured the underlying theme of the conference as well as the latest research trends and scientific findings.

Additionally, we found that our conference participants switched across three rooms 1.5 times on average in a parallel session. Switching across conference rooms suggested that attendees left the meeting without staying in the same conference room until the session ends. It may also indicate more flexibility and control for the participants to choose the talks or presentations they were interested in. For example, participants may be interested in the 1st presentation in room A and the 2nd presentation in room B; thus, they may well switch between the two rooms upon finishing the 1st presentation in room A. In light of this perspective, virtual conferences may help decentralize the conference (Greenhow & Gleason, 2014) for more participant-centered scholarship building.

### 5.2. The overall and individual differences in conference perception, competence, and engagement

In general, participants demonstrated high mastery experience as well as high academic and ICT use competences in attending virtual conferences, while their social interaction competence was significantly lower. Compared with face-to-face conferences, participants attending virtual conferences via video conferencing may experience low social presence (Kreijns et al., 2011), while social presence was a strong positive predictor for learning satisfaction and performance (Richardson et al., 2017). Thus, technological and pedagogical strategies to enhance participants' low social interaction competence warrants more research.

In terms of individual differences in the virtual conference participation experience, our result exhibited a gender gap in academic competence and an association between gender and conference preference. Previous research showed that women presented less time or asked fewer questions than men in academic conferences (Hinsley et al., 2017; Jones et al., 2014). Similarly, our study revealed that women had less competence than men to present, share, or receive research findings than men in the virtual academic conference. Nevertheless, more than expected numbers of women reported being more engaged in virtual conferences than in face-to-face conferences. Virtual conferences may pose a naturally forming shield for some women. Thus, they can focus on presenting their research or participating in the presentation without worrying about the direct disturbance or judgment from others due to the reduced perception of shared space (Taylor, 2011).

Moreover, we observed academic rank differences in mastery experience, engagement, and conference preference. As an exploratory attempt to understand academic rank and conference participation, our results revealed that professional participants perceived higher mastery experience and attended more meetings than student participants in the virtual conference. Besides, in terms of the level of engagement, more than expected numbers of professional participants perceived that virtual conferences were more engaging than face-to-face conferences and that virtual conferences were equally engaging as face-to-face conferences. Meanwhile, more than expected numbers of student participants preferred attending virtual conferences, while more than expected numbers of professional participants preferred attending face-to-face conferences. As a well-known fact, duties for professional participants included attending academic conferences to present or receive the latest development in the field as well as building connections and networking with academic peers around the world. Thus, attending academic conferences is part of the "academic citizenship" (Macfarlane, 2007). These responsibilities can justify the higher mastery experience, more engaging experience, and more virtual conference meetings attended for professional participants. Professional participants' preference toward attending face-to-face conferences provided additional evidence to support their adherence to fulfilling their employment duties.

Notably, traditional conferences tend to deepen the division of social networking of participants with different backgrounds (De Vries & Pieters, 2007). Thus, professional participants are more prone to bond with their existing connections in face-to-face conferences, which, however, may reduce the value of academic conferences (Spilker et al., 2020). Nevertheless, Davidson and Lyon (2018) found that attending academic conference positively impacted undergraduate students' career aspiration and enhanced their sense of belonging to the academic community.

The study findings have profound implications for the conference organizers. Concerning the social constraints in face-to-face conferences, virtual conferences may emerge as technological tool to provide opportunities for networking with proper arrangement by the conference organizers, such as identifying influential people in the community (Wu & Nian, 2021) and supplying connections among attendees using conference management systems (Spilker et al., 2020). In addition, more detailed pre-conference instructions/materials can be delivered to participants (especially student participants) to assist their presentation or recommend presentation sessions to enhance their mastery experiences and engagement. Despite the distinct associations of gender and academic ranks with participants' perceptions and engagement, virtual conferences can be the best of two worlds in order for continuous social and intellectual interaction in the academia amid the pandemic of contagious diseases.

### 5.3. Association among perception, competence, and engagement

In line with Bandura's self-efficacy theory (Bandura, 1977; Bandura, 1996), the results of the structural model confirmed the association among attendees' mastery experience, competence, and engagement in the virtual conference. Specifically, we verified participants' sense of satisfaction with their past success in the virtual conference positively predicted their perceived competence in attending the virtual conference, which in turn predicted more meeting sessions attended (engagement) in the virtual conference. According to the theory, prior

experiences provide the most reliable source of self-efficacy; particularly, past success in the task can strengthen the competence belief to hold out against temporary frustration or failure (Bandura, 1997). For example, in Tschannen-Moran and Hoy (2007), teachers' mastery experience positively predicted their self-efficacy. The association was stronger for novice teachers with fewer prior task success as opposed to the experienced teachers. Given this new form of virtual conferences, we believe that most attendees possess limited mastery experience in virtual conferences; thus, the association will hold for the general population in academia. Moreover, consistent with the well-established association between self-efficacy/competence and engagement (e.g., Granziera & Perera, 2019; Skaalvik & Skaalvik, 2016; Wu, 2017), we revealed a positive relationship between attendees' perceived competence in participating in the virtual conference activities and the number of virtual conference sessions they attended. Findings about the association between mastery experience and competence as well as competence and engagement led to the inference that the more satisfied attendees felt about their virtual conference participation was also related to their engagement in virtual conferences or the number of virtual sessions they attended. Mastery experience, together with competence, had a considerable effect size on engagement in the virtual conference. As an implication for conference organizers, more scaffolds, such as pre-conference instructions and definite program agenda with virtual session links, can be supplied to enhance attendees' mastery experience and their competence in attending virtual conferences.

## 6. Limitation and conclusion

Considering the pandemic around the world, holding conferences in the virtual form appears to be a viable solution to maintain the interactivity and productivity of the research community. More than half of the participants preferred attending virtual conferences, while the rest preferred attending face-to-face conferences in the future. Nevertheless, the study results should be interpreted in light of limitations. First, the study was conducted on participants in the e-Learning domain, whose attendees are prone to the application of innovative technologies in learning. Thus, the research findings may not be generalized to conference attendees in other fields. Second, the study included both unstructured trace data and structured survey data from participants to illustrate participants' explicit behavior on the conference platform and the implicit ratings of their participation experiences. The two sources of data, however, cannot be linked by participants' identities. Future research can be done to link the two data sources for a more comprehensive understanding of participants' conference experience. For example, attendees' trace data (e.g., % of time being present in the sessions) can be used to represent their "true" engagement in the structural model.

Despite the limitations mentioned above, findings of the current study further revealed that virtual academic conferences could have the potential to become the mainstream in organizing future conferences. In this study, we provided the indices from participants' unstructured log to describe their conference-based and session-based behaviors. We also developed the measurement tool of competence in virtual conferences with adequate psychometric properties to identify and compare participants' academic, social interaction and ICT competence about virtual conferences. Based on the analytical results, we demonstrated that virtual conferences could facilitate the extended and deepened participation of the research community (Greenhow et al., 2019; Jardine & Romaniuk, 2009), nourish the participant-centered scholarship building (Greenhow & Gleason, 2014), and create an engaging conference environment that reflects quality experiences regarding participants' mastery experience, competence, and engagement (Granziera & Perera, 2019; Tschannen-Moran & Hoy, 2007). Future research can be designed to test technological and pedagogical strategies that can provide participants a more engaging and rewarding conference experience, especially on refining their social interaction competence.

## Acknowledgement

The authors are grateful to the co-chair and committee members of Taiwan e-Learning Forum 2020, including Professors Sunny San-Ju Lin, Yih-Lan Liu, and Jerry Chih-Yuan Sun. Special thanks to the president of Taiwan E-Learning and Digital Content Association, Chair Professor Ching-Chung Tsai, for his comments and suggestions on the revision of the manuscript. The study was partially supported under the grant number Grant 108-2511-H-009 -013 -MY3 from the Ministry of Science and Technology, Taiwan.

## References

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215. doi:10.1037/0033-295X.84.2.191

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117–148.

Bandura, A. (1997). *Self-efficacy: The Exercise of control*. New York, NY: Freeman.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (1996). Multifaceted impact of self-efficacy beliefs on academic functioning. *Child Development*, *67*(3), 1206–1222.

Biggs, J., Hawley, P. H., & Biernat, M. (2018). The Academic conference as a chilly climate for women: Effects of gender representation on experiences of sexism, coping responses, and career intentions. *Sex Roles*, *78*(5–6), 394–408.

Cain, M. K., Zhang, Z., & Yuan, K.-H. (2017). Univariate and multivariate skewness and kurtosis for measuring nonnormality: Prevalence, influence and estimation. *Behavior Research Methods*, *49*(5), 1716–1735.

Cheng, Y.-H., Tsai, C.-C., & Liang, J.-C. (2019). Academic hardiness and academic self-efficacy in graduate studies. *Higher Education Research & Development*, *38*(5), 907–921. doi:10.1080/07294360.2019.1612858

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, *9*, 233–255.

Chou, C., & Lee, Y.-H. (2017). The Moderating effects of internet parenting styles on the relationship between internet parenting behavior, internet expectancy, and internet addiction tendency. *The Asia-Pacific Education Researcher*, *26*(3–4), 137–146. doi:10.1007/s40299-017-0334-5

Chuang, S.-C., Lin, F.-M., & Tsai, C.-C. (2015). An Exploration of the relationship between Internet self-efficacy and sources of Internet self-efficacy among Taiwanese university students. *Computers in Human Behavior*, *48*, 147–155.

Davidson, J. M., & Lyons, M. (2018). Undergraduates as researchers–the impact of active participation in research and conference presentation on psychology undergraduate identity and career aspirations. *Journal of Perspectives in Applied Academic Practice*, *6*(1), 39–46.

De Vries, B., & Pieters, J. (2007). Knowledge sharing at conferences. *Educational Research and Evaluation*, *13*(3), 237–247.

Granziera, H., & Perera, H. N. (2019). Relations among teachers' self-efficacy beliefs, engagement, and work satisfaction: A Social cognitive view. *Contemporary Educational Psychology*, *58*, 75–84.

Greenhow, C., & Gleason, B. (2014). Social scholarship: Reconsidering scholarly practices in the age of social media. *British Journal of Educational Technology*, *45*(3), 392–402.

Greenhow, C., Li, J., & Mai, M. (2019). From tweeting to meeting: Expansive professional learning and the academic conference backchannel. *British Journal of Educational Technology*, *50*(4), 1656–1672.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). New York, NY: Prentice Hall.

Hall, N. (2015). Delineating the learning process in generating a research culture among undergraduate social work students: A Case study of student participation in an academic conference. *Social Work Education*, *34*(7), 829–845.

Harter, S. (1982). The perceived competence scale for children. *Child Development, 53*(1), 87–97. doi: 10.2307/1129640

Henderson, E. F. (2015). Academic conferences: Representative and resistant sites for higher education research. *Higher Education Research & Development*, *34*(5), 914–925.

Hinsley, A., Sutherland, W. J., & Johnston, A. (2017). Men ask more questions than women at a scientific conference. *PloS One*, *12*(10). doi:10.1371/journal.pone.0185534

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. doi:10.1080/10705519909540118

Jacobs, N., & McFarlane, A. (2005). Conferences as learning communities: Some early lessons in using 'back-channel'technologies at an academic conference–distributed intelligence or divided attention? *Journal of Computer Assisted Learning*, *21*(5), 317–329.

Jardine, B., & Romaniuk, J. (2009). *Influences on audience inheritance in Australian television viewing*. Melbourne, Australia: ANZMAC.

Jardine, B., Romaniuk, J., Dawes, J. G., & Beal, V. (2016). Retaining the primetime television audience. *European Journal of Marketing*, 50(7/8), 1290-1307. doi:10.1108/EJM-03-2015-0137

Jokisch, M. R., Schmidt, L. I., Doh, M., Marquard, M., & Wahl, H.-W. (2020). The Role of internet self-efficacy, innovativeness and technology avoidance in breadth of internet use: Comparing older technology experts and non-experts. *Computers in Human Behavior*, 106408. doi:10.1016/j.chb.2020.106408

Jones, T. M., Fanson, K. V., Lanfear, R., Symonds, M. R., & Higgie, M. (2014). Gender differences in conference presentations: A Consequence of self-selection? *PeerJ*, *2*, e627. doi:10.7717/peerj.627

Kellogg, W. A., Erickson, T., Wolf, T. V., Levy, S., Christensen, J., Sussman, J., & Bennett, W. E. (2006). Leveraging digital backchannels to enhance user experience in electronically mediated communication. In *Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work* (pp. 451–454). New York, NY: ACM.

Kimmons, R., & Veletsianos, G. (2016). Education scholars' evolving uses of twitter as a conference backchannel and social commentary platform. *British Journal of Educational Technology*, *47*(3), 445–464.

Kline, R. B. (2010). *Principles and practice of structural equation modeling* (3rd ed.). New York, NY: The Guilford Press.

Kreijns, K., Kirschner, P. A., Jochems, W., & Van Buuren, H. (2011). Measuring perceived social presence in distributed learning groups. *Education and Information Technologies*, *16*(4), 365–381.

Látková, P., Wu, H.-C. J., & Paulsen, R. D. (2009). Examining social capital in the conference setting: A Case study of college student participants. *SCHOLE: A Journal of Leisure Studies and Recreation Education*, *24*(1), 38–49.

Lee, M.-H., Hsu, C.-Y., & Chang, C.-Y. (2019). Identifying Taiwanese teachers' perceived self-efficacy for Science, Technology, Engineering, and Mathematics (STEM) knowledge. *The Asia-Pacific Education Researcher*, *28*(1), 15–23.

Lee, Y.-H., & Wu, J.-Y. (2013). The Indirect effects of online social entertainment and information seeking activities on reading literacy. *Computers & Education*, *67*, 168–177. doi:10.1016/j.compedu.2013.03.001

Little, C. (2020). Undergraduate research as a student engagement springboard: Exploring the longer-term reported benefits of participation in a research conference. *Educational Research*, 1–17.

Luan, H., Geczy, P., Lai, H., Gobert, J., Yang, S. J. H., Ogata, H., Baltes, J., Guerra, R., Li, P., & Tsai, C.-C. (2020). Challenges and future directions of Big Data and Artificial Intelligence in education. *Frontiers in Psychology*, *11*, 580820.

Macfarlane, B. (2007). Defining and rewarding academic citizenship: The Implications for university promotions policy. *Journal of Higher Education Policy and Management*, *29*(3), 261–273.

Mata, H., Latham, T. P., & Ransome, Y. (2010). Benefits of professional organization membership and participation in national conferences: Considerations for students and new professionals. *Health Promotion Practice*, *11*(4), 450–453.

Mehta, P. D., & Neale, M. C. (2005). People are variables too: Multilevel structural equations modeling. *Psychological Methods*, *10*(3), 259–284.

Meredith, W. (1993). Measurement invariance, factor analysis and factorial invariance. *Psychometrika*, *58*(4), 525–543.

Mervosh, S., Lu, & Swales, V. (2020, April 7). Which states and cities have told residents to stay at home. *The New York Times*. Retrieved from https://www.nytimes.com/interactive/2020/us/coronavirus-stay-at-home-order.html

Meyer, D., & Hyndman, R. J. (2006). The Accuracy of television network rating forecasts: The effects of data aggregation and alternative models. *Model Assisted Statistics and Applications*, *1*(3), 147–155.

Millsap, R. E. (2011). *Statistical approaches to measurement invariance* (1st ed.). New York, NY: Routledge.

Moore, C., Fisher, T., & Baber, E. (2016). Virtually unknown: Teacher engagement in an online conference. *ELT Journal*, *70*(2), 200–211.

Richardson, J. C., Maeda, Y., Lv, J., & Caskurlu, S. (2017). Social presence in relation to students' satisfaction and learning in the online environment: A Meta-analysis. *Computers in Human Behavior*, *71*, 402–417.

Rosseel, Y., Jorgensen, T. D., Oberski, D., Byrnes, J., Vanbrabant, L., Savalei, V., Merkle, E., Hallquist, M., Rhemtulla, M., Katsikatsou, M., Barendse, M., & Scharf, F. (2019). *lavaan: Latent variable analysis* (0.6-5) [Computer software]. Retrieved from https://CRAN.R-project.org/package=lavaan

Spilker, M., Prinsen, F., & Kalz, M. (2020). Valuing technology-enhanced academic conferences for continuing professional development. A Systematic literature review. *Professional Development in Education*, *46*(3), 482–499.

Sugimoto, C. R., Work, S., Larivière, V., & Haustein, S. (2017). Scholarly use of social media and altmetrics: A Review of the literature. *Journal of the Association for Information Science and Technology*, *68*(9), 2037–2062.

Taylor, T. (2011). Video conferencing us talking face-to-face: Is video suitable for supportive dialogue? *International Journal of Therapy and Rehabilitation, 18*(7), 392–402.

The R Core Team. (2020). *R: A Language and environment for statistical computing* (3.6.3) [Computer software]. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.207.1436

Tschannen-Moran, M., & Hoy, A. W. (2007). The Differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and Teacher Education*, *23*(6), 944–956.

Wu, J.-Y. (2014). Gender differences in online reading engagement, metacognitive strategies, navigation skills and reading literacy. *Journal of Computer Assisted Learning*, *30*(3), 252–271. doi:10.1111/jcal.12054

Wu, J.-Y. (2017). The Indirect relationship of media multitasking self-efficacy on learning performance within the personal learning environment: Implications from the mechanism of perceived attention problems and self-regulation strategies. *Computers & Education*, *106*, 56–72. doi:10.1016/j.compedu.2016.10.010

Wu, J.-Y. (2020). Learning analytics on structured and unstructured heterogeneous data sources: Perspectives from procrastination, help-seeking, and Machine-Learning defined cognitive engagement. *Computers & Education*, 104066. doi:10.1016/j.compedu.2020.104066

Wu, J.-Y., & Cheng, T. (2019). Who is better adapted in learning online within the personal learning environment? Relating gender differences in cognitive attention networks to digital distraction. *Computers & Education*, *128*, 312–329.

Wu, J.-Y., Hsiao, Y.-C., & Nian, M.-W. (2020). Using supervised machine learning on large-scale online forums to classify course-related Facebook messages in predicting learning achievement within the personal learning environment. *Interactive Learning Environments, 28*(1), 65-80. doi: 10.1080/10494820.2018.1515085

Wu, J.-Y., & Hughes, J. N. (2015). Teacher network of relationships inventory: Measurement invariance of academically at-risk students across ages 6 to 15. *School Psychology Quarterly*, *30*(1), 23–36. doi:10.1037/spq0000063

Wu, J.-Y., & Kwok, O. (2012). Using structural equation modeling to analyze complex survey data: A Comparison between design-based single-level and model-based multi-level approaches. *Structural Equation Modeling - A Multidisciplinary Journal*, *19*(1), 16–35. doi:10.1080/10705511.2012.634703

Wu, J.-Y., Kwok, O., & Willson, V. L. (2014). Using design-based latent growth curve modeling with cluster-level predictor to address dependency. *The Journal of Experimental Education*, *82*(4), 431–454. doi:10.1080/00220973.2013.876226

Wu, J.-Y., Lee, Y.-H., & Lin, J. J. H. (2018). Using iMCFA to perform the CFA, multilevel CFA, and maximum model for analyzing complex survey data. *Frontiers in Psychology*, *9*. doi:10.3389/fpsyg.2018.00251

Wu, J.-Y., Lin, J. J. H., Nian, M.-W., & Hsiao, Y.-C. (2017). A Solution to modeling multilevel confirmatory factor analysis with data obtained from complex survey sampling to avoid conflated parameter estimates. *Frontiers in Psychology*, *8*, 1464.

Wu, J.-Y., & Nian, M.-W. (2021). The Dynamics of an online learning community in a hybrid statistics classroom over time: Implications for the question-oriented problem-solving course design with the social network analysis approach. *Computers & Educatio*n, 104120. doi:10.1016/j.compedu.2020.104120

Wu, J.-Y., & Peng, Y.-C. (2017). The Modality effect on reading literacy: Perspectives from students' online reading habits, cognitive and metacognitive strategies, and web navigation skills across regions. *Interactive Learning Environments*, *25*(7), 859–876. doi:10.1080/10494820.2016.1224251

Wu, J.-Y., Yang, C.C.Y., Liao, C.-H., & Nian, M.-W. (2021). Analytics 2.0 for precision education: An Integrative theoretical framework of the human and machine symbiotic learning. *Educational Technology & Society, 24*(1), 267-279.

## Supplementary material

*Table S.1.* The Virtual Conference Mastery Experience (VCME) Scale

| Mastery Experience (VCME) | |
|---|---|
| S1 | I am satisfied with my experience in participating in the keynote speeches of this virtual conference |
| S2 | I am satisfied with my experience in participating in the oral presentations of this virtual conference |
| S3 | I am satisfied with my overall experience in this virtual conference |

*Table S.2.* The Virtual Conference Self Competence (VCSC) Scale

| Social Interaction Competence (VCSC-SIC) | |
|---|---|
| SIC1 | I am certain I can make new friends in the virtual conference. |
| SIC2 | I am able to meet my research fellows in the virtual conference. |
| SIC3 | It is easy for me build up connections with academic peers in the virtual conference. |
| ICT Use Competence (VCSC-ICT) | |
| ICT1 | I am able to switch between rooms and attend more parallel sessions in the virtual conference. |
| ICT2 | I can have more time to prepare my presentations or listen to others in the virtual conference. |
| ICT3 | I am certain that I can save the travel cost and time for attending the virtual conference |
| ICT4 | I am confident that I can switch between slides and other media during my presentation. |
| Academic Competence (VCSC-AC) | |
| AC1 | I believe I can obtain the latest research development or trends in the virtual conference. |
| AC2 | I think I can concentrate on the presentation contents in the virtual conference. |
| AC3 | I can share my academic works effectively in the virtual conference. |