Digital Divide and Participation Barriers in Hybrid Arts Education Programs

Authors

Minji Kim[1], Joonho Park[2], Seoyeon Lee[3*]

Affiliations

Faculty of Fine Arts and Music, The University of Melbourne, Southbank, VIC 3006, Australia

***Corresponding author:** seoyeon.lee@ucl.ac.uk

Abstract

This study investigates how the digital divide shapes student participation barriers in hybrid arts education programs. The study is designed to collect data from approximately 720 students enrolled in 30 hybrid arts-related programs across urban, suburban, and community learning centers. Data sources include student questionnaires, platform login records, online attendance data, assignment submission logs, teacher feedback records, and interview transcripts. The study measures device availability, internet stability, home learning space, digital literacy, platform familiarity, online attendance rate, login frequency, assignment completion rate, feedback reception frequency, peer interaction frequency, learning satisfaction, and dropout intention. Quantitative analysis applies logistic regression, multiple regression, mediation analysis, latent class analysis, and group comparison to identify different types of participation barriers and learner profiles. The study further examines whether digital literacy and teacher support mediate the relationship between technological access and learning continuity. Based on latent class analysis, students can be classified into groups such as high-access active learners, digitally constrained persistent learners, low-support inactive learners, and high-risk disengaged learners. Interview data from approximately 50 students are used to explain why some learners remain formally enrolled but become inactive in online learning tasks. The innovation of this study lies in moving beyond a simple access-based view of the digital divide and building a multidimensional model that connects technology access, platform behavior, teacher support, and sustained participation in hybrid arts education.

Keywords: digital divide; hybrid arts education; participation barriers; digital inclusion; learning analytics; latent class analysis; learning continuity

1. Introduction

Hybrid arts education integrates face-to-face instruction with online lessons, digital demonstrations, platform-based assignments, virtual communication, and remote feedback. This model has become increasingly important as educational institutions seek to provide more flexible learning opportunities while maintaining interaction between teachers and students. Compared with fully classroom-based instruction, hybrid learning allows students to revisit recorded

materials, access learning resources beyond scheduled class hours, and complete some learning activities at their own pace. These advantages may be particularly valuable in arts education, where repeated observation, practice, revision, and feedback are often necessary for skill development. However, meaningful participation in hybrid learning depends on access to suitable digital devices, reliable internet connections, appropriate home learning environments, and sufficient digital skills. These conditions are unevenly distributed across student populations. Students from low-income households or less supported communities may have to share devices, rely on unstable internet connections, or complete learning tasks without adequate technical assistance [1,2]. As a result, the digital divide increasingly refers not only to physical access to technology but also to differences in the ability to use digital resources effectively and convert such access into sustained educational participation. Research across different educational contexts has shown that family resources, digital competence, institutional support, and technology-use patterns jointly influence students' online learning experiences and outcomes [3,4]. Device ownership alone therefore provides only a partial explanation of inequality in hybrid education.

The organization of teaching resources and the design of instructional interaction are also important for effective arts education in digitally supported environments. Recent research on public art education has shown that collaborative teaching arrangements and the optimization of teaching-resource allocation can improve the efficiency with which instructional resources are organized and shared, highlighting the importance of coordinating teaching models with available educational resources [5]. This issue is closely related to hybrid arts education, where teachers must distribute demonstrations, assignments, feedback, learning materials, and communication opportunities across both physical and digital environments. Students may technically access a platform while participating only minimally in meaningful learning activities. Some regularly log in but seldom contribute to discussions, submit assignments, respond to teacher comments, or interact with peers, whereas others remain formally enrolled but gradually disengage from online components of the course. Studies of blended and HyFlex learning suggest that such differences are associated with task clarity, teacher guidance, platform familiarity, instructional organization, and the balance between online and classroom activities [6,7]. These findings indicate that access to technology and actual educational participation should be treated as related but distinct dimensions. The challenges are especially pronounced in arts education because artistic learning often requires forms of interaction that are difficult to reproduce through general-purpose digital platforms. Visual arts students may need high-resolution images, specialist design software, digital portfolios, and large file uploads. Music students may depend on acceptable sound quality, synchronized demonstrations, and detailed performance feedback. Dance and theatre courses involve body movement, spatial awareness, physical coordination, group rehearsal, and immediate interpersonal responses [8,9]. Studio space, equipment, instruments, materials, and opportunities for collaborative practice may also influence whether students can participate effectively outside

the classroom [10,11]. Online environments can extend access to demonstrations and learning materials, but they cannot automatically reproduce the physical, sensory, and social conditions of studio-based education. Research on visual and performing arts teaching has found that digital platforms can support communication, creative-work sharing, and instructional continuity, although their effectiveness depends heavily on appropriate task design, active teacher involvement, and the adaptation of pedagogical practices to online conditions [12,13]. Studies of online performing arts education have similarly indicated that effective digital teaching requires pedagogical redesign rather than the direct transfer of conventional classroom activities to an online platform [14].

Digital literacy further affects whether students can benefit from these instructional resources. In hybrid arts courses, students are often required to navigate learning platforms, upload multimedia files, use communication tools, operate discipline-specific software, review digital feedback, and participate in online collaborative activities. Students with limited digital competence may therefore experience difficulties even when devices and internet access are available [15,16]. Technical problems can delay assignment submission, reduce participation in synchronous sessions, and discourage students from using optional learning resources. At the same time, teacher assistance and peer interaction may reduce some of these difficulties by helping students solve technical problems, interpret course requirements, and remain connected to the learning community [17,18]. Existing studies have linked stronger digital literacy and online social support with more effective educational technology use and higher levels of student participation [19,20]. This suggests that the effect of technical access on learning continuity may operate partly through students' ability to use digital tools and through the support available within the learning environment. Participation in hybrid learning should also be understood as a multidimensional process rather than a single measure of attendance or enrollment. Formal enrollment records indicate whether students remain registered in a course, but they do not reveal whether students continue to engage with learning activities. A student may remain enrolled while rarely accessing online materials, missing virtual sessions, failing to submit assignments, or avoiding teacher and peer interaction [21,22]. Conversely, another student may experience technical difficulties but remain highly engaged through repeated platform use, active communication, and timely completion of learning tasks. Login frequency, online attendance, assignment submission, feedback response, and peer interaction can therefore provide more direct evidence of behavioral participation than enrollment status alone. Examining these indicators together may help distinguish temporary access problems from more persistent patterns of disengagement and may also reveal whether different combinations of barriers are associated with different forms of participation. Despite growing research on digital inequality and hybrid education, several limitations remain. A substantial proportion of previous research was conducted during periods of emergency remote teaching, when institutions and students had limited time to prepare for online learning. Findings from these settings may not fully represent more stable

hybrid teaching environments in which digital and classroom components are deliberately integrated. Many studies have also focused on a single institution, course, or student group, limiting the extent to which results can capture variation across different educational settings [23,24]. In addition, research commonly relies on self-reported questionnaires and interviews, while behavioral records such as platform logins, online attendance, assignment submission, teacher feedback, and peer interaction are used less frequently. Self-reported measures are valuable for understanding students' perceptions, but they may not fully reflect actual patterns of participation. Combining subjective and behavioral data can therefore provide a more complete account of how digital barriers influence learning activity. Another limitation is that digital barriers are often examined independently. Device access, internet quality, home learning conditions, digital literacy, teacher support, and peer interaction may occur simultaneously and may reinforce or compensate for one another. A student with weak internet access but strong teacher support, for example, may show a different participation pattern from a student who has reliable technology but limited digital skills and little interaction with teachers or peers. Conventional regression models are useful for estimating average relationships between individual factors and outcomes, but average effects may conceal meaningful differences between groups of learners. Person-centered methods can complement variable-centered analysis by identifying clusters of students who experience distinct combinations of technical, social, and instructional conditions. This distinction is particularly relevant to hybrid arts education because participation depends on both access to digital infrastructure and the ability to engage in practical, creative, and collaborative learning activities.

Against this background, the present study examines how technological access, digital literacy, learning support, and platform behavior influence continued participation in hybrid arts education. The study draws on approximately 720 students enrolled in 30 hybrid arts programs across urban, suburban, and community learning centers, allowing participation patterns to be examined across diverse educational environments. Questionnaire data are combined with behavioral records, including platform logins, online attendance, assignment submissions, teacher feedback, and peer interaction, together with interviews involving approximately 50 students. Logistic regression and multiple regression are used to examine the relationships between major access and support factors and different participation outcomes, while mediation analysis evaluates whether digital literacy and teacher support help explain the relationship between technical access and learning continuity. Latent class analysis is further used to identify groups of learners characterized by different combinations of barriers, resources, and participation behaviors, followed by group comparisons to clarify how these learner types differ in educational engagement. By distinguishing formal enrollment from active participation, the study seeks to move beyond a simple access-based understanding of the digital divide. Its purpose is not only to determine whether students possess devices or internet connections, but also to examine whether they can translate these resources into regular attendance, assignment completion, interaction,

feedback use, and sustained involvement in hybrid arts learning. The study contributes to research on digital inequality by integrating technical, behavioral, instructional, and social dimensions within the same analytical framework. It also extends hybrid-learning research into arts education, where the requirements for practical demonstration, creative production, specialist resources, and interpersonal feedback make digital participation particularly complex. From a practical perspective, identifying different patterns of participation barriers can help institutions determine which students require technological assistance, digital-skills support, instructional intervention, or stronger teacher and peer engagement. The findings may therefore support more targeted allocation of teaching resources, more responsive hybrid course design, and more inclusive strategies for maintaining active participation among students with different levels of digital access and learning support.

2. Materials and Methods

2.1 Participants and Study Settings

This study included 720 students from 30 hybrid arts programs in urban, suburban, and community learning centers. The programs covered visual arts, music, dance, theatre, digital media, and design. Stratified cluster sampling was used to select programs from areas with different levels of digital access. Students were included when they had attended the program for at least four weeks and had completed both classroom and online activities. The sample consisted of 286 males and 434 females aged 15–54 years, with a mean age of 26.8 years. Among the participants, 38% came from households below the local median income, 29% shared a digital device with family members, and 33% reported unstable home internet access. About 42% had little experience with online learning platforms. Fifty students were selected for interviews based on digital access, platform activity, attendance, and dropout risk.

2.2 Study Design and Comparison Groups

A 10-week quasi-experimental design was used. Fifteen programs were placed in the digital support group, and the other fifteen formed the comparison group. The programs were matched by art type, location, class size, student age, and baseline online attendance. Students in the digital support group received device loans, internet support, platform training, weekly technical help, and fixed times for teacher feedback. Teachers also used shorter online tasks, smaller media files, and clear submission guides. The comparison group continued its regular hybrid teaching without added digital support. Data were collected in Weeks 1, 5, and 10. This design separated changes related to digital support from those caused by normal course progress and greater platform experience.

2.3 Measures and Quality Control

Digital access was measured through device availability, internet stability, home learning space, and access to required software. Digital literacy and platform familiarity were measured with 18 items on a five-point scale. Separate scales were used to measure teacher support, peer interaction, learning satisfaction, and dropout intention. Platform records included login frequency, online attendance, session length, assignment completion, feedback receipt, and peer response frequency. Three education researchers, two arts teachers, and one platform manager reviewed the questionnaire. A pilot test with 52 students was used to identify and revise unclear items. Cronbach's alpha values above 0.70 were accepted. Platform records were linked to questionnaire data through coded student numbers. Duplicate entries, automated logins, and sessions shorter than two minutes were removed. Ten percent of the records were checked against the original platform files.

2.4 Data Processing and Statistical Models

The data were analyzed using descriptive statistics, group comparison, multiple regression, logistic regression, mediation analysis, and latent class analysis. Missing questionnaire values below 5% were handled by multiple imputation. Continuous variables were standardized before analysis. A participation continuity index was calculated from online attendance, login activity, assignment completion, and feedback response:

$$PCI_i = 0.30A_i + 0.20L_i + 0.30S_i + 0.20F_i$$

where A_i is online attendance, L_i is login activity, S_i is assignment completion, and F_i is feedback response for student i. Dropout risk was tested with the following logistic regression model:

$$\log\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 DA_i + \beta_2 DL_i + \beta_3 TS_i + \beta_4 HS_i + \sum_{k=1}^{m} \gamma_k X_{ki}$$

where P_i is the probability of high dropout risk, DA_i is digital access, DL_i is digital literacy, TS_i is teacher support, and HS_i is the home learning condition. The control variables included age, gender, income, program type, and prior online learning experience. Model fit was assessed using likelihood ratio tests, information criteria, and classification accuracy. Statistical significance was set at $p<0.05$.

2.5 Learner Profiles Interviews and Ethical Approval

Latent class analysis was used to identify student groups with different patterns of digital access, learning support, and platform activity. Models with two to six classes were compared using AIC, BIC, entropy, and class size. The final classes were defined by device access, internet stability, digital literacy, teacher support, attendance, and assignment completion. Semi-structured interviews were conducted with 50 students from the main groups. Each interview lasted 30–45 minutes and covered technical problems, home learning conditions, platform use, teacher contact, peer interaction, and reasons for low online activity. Two researchers coded the interview records

separately and compared their results. Cohen's kappa was used to measure coding agreement, and values above 0.80 were accepted. All records were anonymized, and personal information was stored separately from the research data. Participants received written information about the study and could withdraw at any time. Ethical approval was obtained before data collection.

3. Results and Discussion

3.1 Data Quality and Initial Participation Gaps

After data cleaning, 696 of the 720 student records were retained, with a valid rate of 96.7%. The digital support group and the comparison group each included 348 students. No significant baseline differences were found in age, gender, household income, previous online learning experience, or program type ($p>0.10$). Cronbach's alpha values for digital literacy, platform familiarity, teacher support, learning satisfaction, and dropout intention ranged from 0.79 to 0.90. The matching rate between questionnaire data and platform records was 97.6%. At baseline, students with unstable internet access completed 18.4% fewer online tasks than those with stable access. Students who shared devices also logged in less often and spent less time online. However, limited access was not the only cause of low participation. Some students had suitable devices but remained inactive because they lacked platform skills or received little teacher feedback [25]. This result supports the use of both questionnaire and platform data. Gao et al. (2026) also found that attendance, homework completion, social background, and learning records should be examined together because one data source cannot fully explain student behavior.

3.2 Effects of Digital Support on Continued Participation

The participation continuity index increased from 0.59 to 0.77 in the digital support group and from 0.60 to 0.65 in the comparison group. Online attendance in the support group rose from 68.4% to 82.7%, while assignment completion increased from 64.8% to 81.9%. The feedback response rate increased from 55.6% to 75.1%. Smaller changes were found in the comparison group, where the final rates were 73.0%, 69.4%, and 61.0%, respectively. Significant group-by-time effects were found for attendance, assignment completion, feedback response, and the continuity index ($p<0.001$). Effect sizes ranged from 0.071 to 0.134. Mean dropout intention fell from 3.31 to 2.54 in the support group but changed only from 3.28 to 3.11 in the comparison group. Device loans reduced access problems, while platform training and smaller media files made online tasks easier to complete [26]. Fixed feedback times also helped students plan their work. These results agree with Xu et al. (2026), who found that planned learning activities do not always lead to active participation. Their study also showed that teacher guidance and suitable use of digital tools are important for student engagement [27].

3.3 Factors Linked to Student Disengagement

Logistic regression showed that unstable internet access increased the odds of high dropout risk by 2.08 times. Sharing a device increased the odds by 1.61 times, while poor home learning space increased them by 1.47 times. Higher digital literacy and stronger teacher support reduced dropout risk, with odds ratios of 0.66 and 0.57, respectively. Path analysis showed that digital access had a total effect of 0.44 on participation continuity. The indirect effect through digital literacy was 0.13, while the indirect effect through teacher support was 0.10. The direct effect was 0.21. These paths are shown in Fig. 1. The results indicate that devices and internet access are important, but they are not enough on their own [28,29]. Students also need the skills to use the platform and timely help from teachers. Zhang et al. (2026) also linked digital confidence with online engagement, although their sample included only 110 first-year students. Wu et al. (2025) described the digital divide as a combined problem of access, skills, social conditions, and institutional support. The present study adds platform activity to this model and shows how these factors affect continued participation in hybrid arts programs.

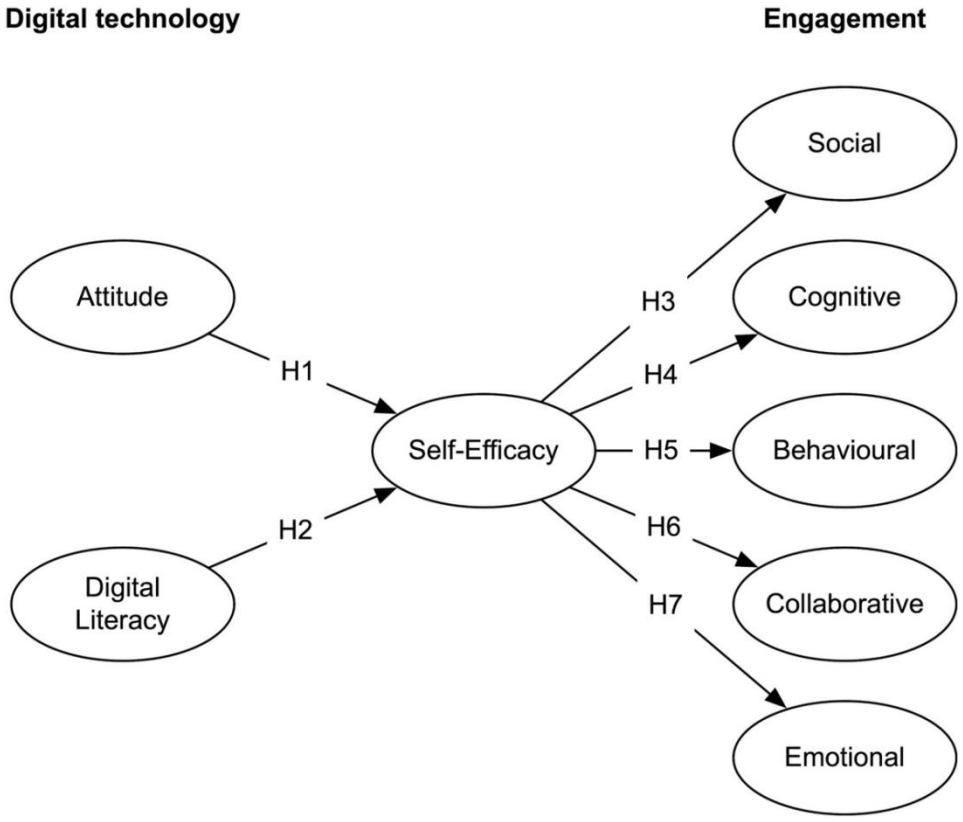

Fig. 1. Effects of digital access digital skills and teacher support on continued participation and dropout intention.

3.4 Learner Profiles and Interview Findings

Latent class analysis identified four student groups, with an entropy value of 0.88. High-access active learners made up 36.1% of the sample. They had stable internet access, strong digital skills, frequent teacher contact, and an assignment completion rate of 92.1%. Digitally constrained persistent learners accounted for 26.7%. Although they had limited access, regular

teacher support helped them maintain a completion rate of 76.8%. Low-support inactive learners represented 21.4%, while high-risk disengaged learners represented 15.8%. The high-risk group had an online attendance rate of 47.5%, an assignment completion rate of 43.2%, and a mean dropout intention score of 4.12. The four groups are shown in Fig. 2. Interview results helped explain these patterns. Among the 50 interviewees, 43 stated that low participation was caused by several problems rather than one single barrier. Thirty-one mentioned slow teacher feedback, 27 reported difficulty uploading large media files, and 24 shared devices with family members. Students in the persistent group often used public internet services or completed tasks outside normal study hours [30]. Parmar et al. (2025) also identified four groups based on technology use, confidence, and institutional support. Their study focused on university teachers, while the present study classified students using access, support, and actual platform records.

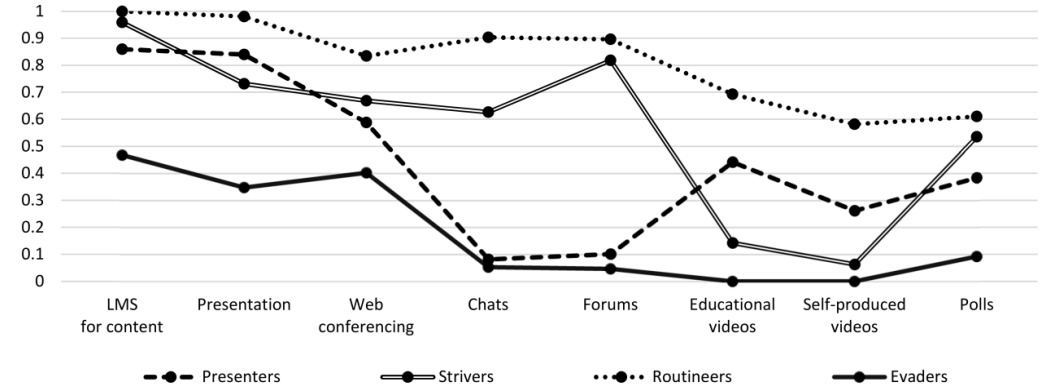

Fig. 2. Student groups based on digital access teacher support and online participation.

4. Conclusion

This study found that digital access, digital skills, teacher support, and home learning conditions all influenced participation in hybrid arts education. Students who received device support, platform training, smaller media files, and regular feedback had higher online attendance and assignment completion. They were also more likely to continue the course and less likely to consider dropping out. Limited access did not always lead to low participation. Some students remained active because they had strong digital skills or timely teacher support. Others had suitable devices but took part less often because they were not familiar with the platform or received little feedback. This study combines questionnaire data, platform records, and interviews to examine different participation barriers and student groups. This method gives a fuller view of the digital divide than device and internet access alone. The findings may help arts programs improve device support, technical training, task design, and early help for students at risk. However, the study included only 30 programs and lasted ten weeks. Some results were also based on self-reported data. Future research should cover more regions, use longer follow-up periods, and include direct measures of learning quality and creative work.

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