Research Article

DOI: https://doi.org/10.18357/otessaj.2025.5.1.76
https://otessa.org
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Unravelling Students' Choice of Course Modality and Flow Experience in Multi-Access University Courses in Relation to Interpersonal Personality Traits

Siem Buseyne
KU Leuven, Faculty of Psychology and Educational Sciences, Centre for Instructional Psychology & Technology, Leuven, Belgium;
KU Leuven, imec research group itec, Leuven, Belgium;
CIREL, Centre Interuniversitaire de Recherche en Education de Lille (ULR 4354), ULille, Lille, France ;
Department of Training and Education Sciences, Faculty of Social Sciences, University of Antwerp, Antwerpen, Belgium

Annelies Raes
KU Leuven, Faculty of Psychology and Educational Sciences, Centre for Instructional Psychology & Technology, Leuven, Belgium

Correspondence:
Annelies Raes
KU Leuven, Faculty of Psychology and Educational Sciences, Centre for Instructional Psychology & Technology, Leuven, Belgium
Email: Annelies.Raes@kuleuven.be

Abstract
Recent developments have led institutions into a transition towards more flexible educational models, such as synchronous hybrid education, i.e., having both on-site and remote students at the same time, or multi-access education also providing asynchronous access. It is assumed that these new models can enhance accessibility for those with diverse learning needs, creating opportunities for inclusive education. However, prior research investigating the relationship between student choice of course modality and personality, and the effect of this choice of delivery mode on affective learning outcomes remains underexplored. The current study fills this gap by exploring student choice behaviour regarding course modality, examining the influence of interpersonal personality traits on these choices, and assessing the impact of course modality on students' flow experiences. This research builds upon prior research on synchronous hybrid education, digital personalized learning, personality, and flow. Our study shows evidence for the significant relation between degree of introversion–extraversion and the choice of course modality, with more introverted students tending to prefer the remote setting compared to the on-campus setting. Moreover, the findings confirmed the influence of course modality on flow experiences. In this respect, our study contributes to the research on personalized learning by showing that current technological evolutions are providing choices about where students learn, in addition to what and how they learn. This creates a new dimension of adaptivity, opening possibilities for inclusive education, yet also adding new challenges.

Keywords: distance education, online learning, improving classroom teaching, teaching and learning strategies, multi-access learning, synchronous hybrid learning, merging modalities

Introduction

In response to the global demand for more flexible and inclusive educational models, many institutions are investing in multi-location education solutions (e.g., Park et al. 2023), aiming to create environments that allow students to access education from various locations of their choice (e.g., Fabian et al., 2024). There is a global need to better deal with rapidly changing contexts and to accommodate the different needs of a diverse learner community (Pelletier et al., 2023; UNESCO, 2020). As pointed out by Irvine (2020), the educational landscape has drastically changed based on evolving needs and technological opportunities, creating some conceptual confusion. Whereas hybrid or blended education used to refer to consecutive modalities (e.g. first an online session, followed by a face-to-face session), nowadays it also refers to concurrent modality mixing (Irvine, 2020, p. 53). In this paper, we use the term multi-access education, since our study considers both synchronous and asynchronous modalities.

Hybrid or blended education has become more popular in recent years, especially during the COVID-19 pandemic, but the educational model is not new, and different conceptualisations have been used over the past 15 years stressing the intermix of physical and virtual spaces at the same time, where both on-site and remote students follow education simultaneously (Bozkurt, 2022; Cohen et al., 2020; Raes et al., 2019) or consecutive, for example in a flipped classroom setting (Bredow et al., 2021). Among the pioneers in the field were Beatty (2007, 2019) with the development of a HyFlex course design model, referring to the facilitation of hybridity and flexibility in education; Irvine (2009) and Irvine et. al (2013) introducing multi-access learning as a framework for enabling students in both face-to-face and online contexts to personalize learning experiences while engaging as a part of the same course; Bell et al. (2014) and Cain et al. (2013) introducing the concept of synchromodal classes; and Bower et al. (2015) investigating blended synchronous learning environments. All these models are designed in a way that they give access to education in different ways, accommodating individual needs and circumstances. This choice in course modality aligns with the principles of personalized learning, which involves customizing the educational experience to match each student's interests, strengths, and/or requirements (Basham et al., 2016). This customization primarily concerns what and how students learn (Bernacki et al., 2021), but it can also include where students learn (Bernacki et al., 2021; Patrick et al., 2013), i.e., personalization of the learning environment.

Although multi-access education facilitates choices regarding course delivery modes, research on how students are dealing with this flexibility is limited. Specifically, there is a gap in our understanding of how and to what extent students transition between different course modalities over time and to what extent student choice of course modality is influenced by individual characteristics. Furthermore, it is important to understand how this personalization of the context influences learning outcomes. These learning outcomes can be of various natures, e.g., cognitive, metacognitive, motivational, and affective (e.g., Van Schoors et al., 2021; Vandewaetere & Clarebout, 2014). Prior research on synchronous hybrid education did not find evidence for significant differences in students' conceptual understanding between the online and remote modality (Raes, 2022). However, prior research revealed that the course modality (i.e., on-site versus remote participation) results in differences in affective engagement (Beatty, 2007, 2019; Raes, Detienne, et al., 2020; Raes, Vanneste, et al., 2020; Raes, 2022; Szeto, 2014; Zydney et al., 2019), with remote students having lower engagement scores and less social connection compared to on-site students. These findings have raised concerns about

whether giving students choice might inadvertently disadvantage some groups. However, it is too soon to draw conclusions about the efficacy of multi-access education by comparing the experiences of in-person versus remote students without considering the design of a specific course and/or learning environment and the individual differences among these students, known as the aptitude-treatment interaction (Snow, 1989). Previous studies often compared student engagement of remote students versus on-site students without considering student characteristics. Yet, as pointed out by Gruppen et al. (2019), learning environments are "living systems" characterized by interactions across psychosocial (i.e., personal, social, organizational) dimensions. One aspect that has rarely been studied in the context of multi-access education is students' choice of course modality in relation to students' personality. This is the focus of the current study. Additionally, this study investigated the effect of the chosen delivery mode on the experience of flow which reflects deep engagement in learning activities. This is important as it provides insight into the potential of multi-access education, and synchronous hybrid education more specifically, as a solution for more inclusive and personalized learning opportunities.

Previous Research and Identification of Gaps

In the subsequent sections, we offer insights into students' choices of delivery modes within multi-access education. Second, we elaborate on recent literature studying how this choice of learning modality influences learning outcomes. Finally, we explore the perspectives on how personal characteristics may moderate the relationship between learning context and these learning outcomes.

Student Choice and Individual Differences

Student choice and flexibility go hand in hand, including the freedom to choose where to study (i.e., the learning environment and learning modality), what to study, when to study, at what pace, and in what order (McCormack, 2023), leading to more personalized learning experiences (e.g., Bernacki et al., 2021; Patrick et al., 2013). Currently, higher education institutions employ many educational technologies to facilitate such choices. More specifically, with the introduction of video conferencing and sophisticated recording and streaming servers, a model has emerged to represent the role of the learner in designating the type of access to learning environments (Irvine, 2009, 2020), also conceptualised as HyFlex learning (Abdelmalak & Parra, 2018).

Multi-access education and HyFlex learning are educational models that integrate both synchronous concurrent, and asynchronous consecutive online learning, in combination with and face-to-face instruction within a single course, offering students the autonomy to decide when and how they participate. While HyFlex affords full agency to the learner, multi-access learning is described as providing learner choice "as designed by the instructor," meaning they may require synchronous activities (in person or online) or asynchronous activities. Embedded in these models are elements of blended learning, providing instructional materials and teaching both in-person and online, thus supporting a more adaptable and flexible learning environment. These models are particularly beneficial in accommodating diverse learner needs and preferences, allowing students to engage with the course content in the mode that best suits their individual circumstances and learning preferences. However, little is known about (a) how students alter between course delivery modes over time and (b) the factors affecting students' choice of delivery mode. Gaining such insights can deepen our understanding of individual differences in learning, helping to explain how students engage with and benefit from different

course modalities. In turn, these insights can guide institutional policymaking by informing the design of hybrid education models, resource allocation, and strategies for improving student engagement and success.

Previous research in the context of multi-access education has shown that different demographic factors can affect students' choice, i.e., age, ethnicity, gender, and discipline (see McPartlan et al., 2021). McPartlan et al. more specifically found that online courses were more likely to see enrolments from women, students of an older age, and those studying part-time. Clayton et al. (2010) also found that psychological factors affect student choice. On the one hand, higher self-efficacy has been identified as a predictor of the willingness to take future courses online (Clayton et al., 2010). On the other hand, there is evidence that more mastery-oriented students prefer on-site learning over online learning, as it better serves their desire to increase knowledge and understanding and to work collaboratively with others (Clayton et al., 2010; O'Neill et al., 2021).

In the specific context of synchronous online learning combining online and on-site learning, Zeng and Bridges (2022) showed that some students chose the online option to avoid social interaction mentioning that it was "Too embarrassing to attend a class with people I don't know," while others chose for the on-site option, hoping for more socialisation. Furthermore, a more recent study conducted by the same authors (Zeng & Bridges, 2023) revealed that students with preferences for stimulating education, cooperative learning, and clearer goals in previous online courses tend to attend synchronous online classes on campus instead of following these courses from their private locations. Qualitative results of their study further highlighted the potential role of personality and self-regulation in students' choices. Therefore, as their findings suggest, a research avenue could involve incorporating personality traits and self-regulation into research on students' choices of course modality.

The observations from previous research referred to above underscore the potential influence of extraversion on students' preferences for learning modalities. Extraverted individuals typically enjoy social interactions and seek out opportunities for engagement (Augustine & Hemenover, 2012). As such, these individuals may be more inclined to select on-site learning formats to satisfy their need for socialization and face-to-face interaction with peers and instructors. Conversely, introverted students feel more comfortable in solitary or less socially demanding environments (Augustine & Hemenover, 2012). Another trait which could influence how students perceive and select their learning environment is collectivism. Collectivism is a personality orientation in which individuals prioritize interdependence and place greater emphasis on the interests of a group. In contrast, individualistic people tend to form more independent and less tightly knit relationships with those in their immediate group and the broader society (Cheng et al., 2020). From a neurodivergent lens, which states that people vary in the way they process and respond to information, creating different educational experiences (Chapman, 2020), it can be hypothesized that some individuals may prefer online modalities to minimize social interaction and focus on independent study. To the best of our knowledge, no previous research has explicitly investigated how students' personality relates to their choice of delivery mode to participate in multi-access education.

Effect of Delivery Mode on Student Learning Outcomes

As suggested by previous research, the choice of delivery mode (e.g., on campus or remote) may in turn affect students' behaviour and engagement within that course. In the specific

context of synchronous hybrid education, prior research has been done (Raes, 2022) focusing on the impact of course modality on conceptual understanding and affective outcomes (i.e., intrinsic motivation, autotelic experience, cognitive absorption, sense of presence, and sense of belonging). From the student's viewpoint, the study revealed no significant disparities in conceptual understanding between physical and remote participation. However, notable differences were observed in affective engagement, favouring on-site students and remote students who had the chance to interact with the teacher compared to students who followed the course through livestream. Furthermore, a study by Wagner et al. (2023) aimed to evaluate a non-pandemic related, systematically developed implementation of a synchronous hybrid classroom in four Austrian vocational high schools. The study focused on on-site and remote students' perspectives about the perceived usability, social presence, and impact that modality had on their engagement and learning. They found that on-site students reported significantly higher levels of perceived usability, social presence, and learning compared to their remote peers. Mentzer et al. (2025) investigated the relationship between students' academic performance and basic psychological needs of a pre-pandemic face-to-face offering compared to an Interactive Synchronous Hybrid approach of the same course enabling students to choose their mode at the end of the pandemic, and found that students in the synchronous hybrid approach perceived their basic psychological needs as being met as effectively or significantly more compared to students in the fully face-to-face offering. A study by McKellar and Wang (2023) longitudinally investigated to what extent academic engagement and school connectedness differed by learning modality in secondary education during COVID. During a period of 11 school days, each day it was assessed if the students had experienced in-person learning and/or remote learning. Based on these data a student-level category was created to represent student learning modality. Students who only reported remote learning every weekday were designated as remote learners. Students who reported in-person learning every day (i.e., learning in school all or much of the day), were designated as in-person learners. Students who indicated that they learned in person on some days and remotely on other days were designated as hybrid learners. Results revealed that academic engagement and connectedness to teachers and classmates were higher for in-person learners than for students in (consecutive) hybrid and remote learning modalities. Moreover, it was found that students' connectedness to classmates and teachers mediated the relationship between learning modality and academic engagement

The present study sought to delve deeper into flow experience in multi-access education because the construct covers cognitive, affective, and physiological aspects (Biasutti, 2011). The concept was first introduced by Csikszentmihalyi (1975), as an optimal experience "during which people are deeply motivated to persist in their activities" (Abbassi et al., 2021, p. 246). According to Schmidt (2010), an exploration of students' learning experiences through the lens of flow theory offers valuable insights for both researchers and educators, shedding light on the individual and contextual elements that foster students' profound engagement in the learning process. Nakamura and Csikszentmihalyi (2014) characterize flow using the following aspects: intense and focused concentration, integration of action and awareness, decreased self-consciousness, feeling in control of one's actions, altered perception of time, and intrinsic reward in the activity itself.

The Role of Interpersonal Personality Traits for Flow Experience

Previous research has shown that some people are more prone to experiencing flow under certain conditions (e.g., Olčar, 2019). As such, academics also refer to the concept of an

autotelic personality (e.g., Baumann, 2012). Based on previous literature, Tse et al. (2021) distinguished seven attributes of an autotelic personality: (a) curiosity and interest in life, (b) persistence, (c) low self-centeredness, (d) intrinsic motivation, (e) enjoyment and transformation of boredom, (f) enjoyment and transformation of challenges, and (g) attentional control.

Furthermore, the propensity to experience flow is also studied in relation to personality traits. This connection has been researched in different contexts, focusing on a wide range of personality traits (Delle Fave & Bassi, 2016). Most research measures personality through the five-factor personality model, also referred to as the Big Five Model (McCrae & Costa, 2008a, 2008b); it remains the most widely accepted model of personality trait structures. It includes extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience as the main dimensions. Over the years, various conceptualizations of the Big Five dimensions have been formulated (e.g., Costa & McCrae, 1995; Soto & John, 2017). Most studies exploring the relationship between the Big Five personality traits and the experience of flow affirm that individuals with higher levels of extraversion tend to experience greater levels of flow (Ahmad & Abdulkarim, 2019; Heller et al., 2015; Liu & Csikszentmihalyi, 2020; Mesurado & de Minzi, 2013; Moon et al., 2014; Ross & Keiser, 2014; Ullén et al., 2016). Yet, context seems to have an important influence on this relationship. Research by Liu and Csikszentmihalyi (2020) has shown, for example, that extraverted people (versus introverted people) experience higher intensity flow in social activities. In solitary activities, however, the level of extraversion does not seem to have an important impact on flow intensity (Liu & Csikszentmihalyi, 2020).

Research Questions and Hypotheses

Given the pressing need for additional exploration in the domain of multi-access education and considering prior research in this area, our study expands the investigation into students' choice regarding course modality, its relationship with interpersonal personality traits, and its consequent influences on their flow experience more particularly to provide insight into the opportunities of multi-access education for inclusive and personalized education.

Our first objective was explorative in nature, to get insights into how students altered between the various course modalities - further explained in the Methods section - over four sessions. Specifically, we sought to answer the following research questions:

RQ1.1 What trends can be discerned in students' choices of modality over time?
RQ1.2 Do modality selections and trends vary among different courses?

Second, building upon previous literature, which has explored the influence of students' characteristics on their choice of course modality mostly in consecutive hybrid approaches, this research sought to extend this understanding to the specific context of synchronous or concurrent hybrid education. Based on previous research, our study focused on two personality traits: extraversion and collectivism. Thus, we posed another research question:

RQ2 "How do the personality traits of Extraversion and Collectivism influence students' choice of modality?"

We hypothesized that (H2.1) students scoring higher on extraversion and collectivism would be more likely to participate in the course from the on-campus setting compared to the remote setting because extraverts thrive in social interactions and face-to-face engagement (Augustine

& Hemenover, 2012), while collectivists prioritize group-oriented environments, which are better facilitated on campus (Cheng et al., 2020). Conversely, we expected that students scoring higher on Introversion and being more individually oriented would be more likely to participate in the remote setting. Additionally, we hypothesized that (H2.2) students in the remote setting, scoring higher on these dimensions would be more likely to choose the specific modality with interaction (further explained in the Methods section).

Third, previous research has investigated differences in students' learning outcomes across different modalities. However, research has not yet looked into how participation in a specific course modality influences students' learning experience based on flow theory. Therefore, the third aim of this study is to investigate the influence of course modality (on-site /remote, with or without interaction) on students' flow experiences. Another research question was thus formulated:

(RQ3) How does the course modality influence students' flow experience?

Correspondingly, the hypotheses were: (H3.1.1) students participating in on-site courses experience higher levels of flow compared to those participating remotely, and (H3.1.2) students participating remotely with interaction experience higher levels of flow compared to students participating remotely without interaction. Furthermore, based on previous literature on flow proneness and autotelic personality, we expected that personality traits such as extraversion and collectivism would influence students' flow experience, specifically in learning settings with interaction. As such, we hypothesize that H3.2 students scoring higher on extraversion and collectivism would experience higher levels of flow in course modalities with interaction.

Methods

Ethical Approval

This research project has been evaluated and approved by the Social and Societal Ethics Committee of KU Leuven (G- 2018 06 1264). One week prior to the course's commencement, students were acquainted with the study's objectives through a 5-minute video disseminated via the learning management system. The video explicitly informed participants about the data collection methods, including a video recording of the course, self-reports, and data from the learning platform. It was also communicated that all collected data would be pseudonymized to ensure privacy. Participation in the study was voluntary, requiring students to sign an informed consent form. Additionally, students were requested to provide consent for being photographed during the course sessions.

Context and Design

The study was conducted during March 2021, in the context of two courses: (a) law of obligations and (b) persons and family law and family asset planning, delivered within the same hybrid lecture hall at KU Leuven in Flanders, Belgium (see Figure A1). The courses were each taught by a different professor from within the Faculty of Law and were delivered across multiple sessions. The participant pool comprised 106 students (21% male and 79% female) of which 71 were first-year bachelor's students and 35 were second-year bachelor's students. Both courses were given during the second semester of the academic year 2020-2021 and our data collection was conducted during the fourth session of the course.

Due to COVID-19 restrictions, on-site participation was limited, adhering to social distancing guidelines. To control on-site participation, students had been asked to subscribe for a course modality by means of a subscription tool in the learning management system, and they could indicate how they would like to follow the course, choosing between four delivery options (three of these are visualized and labelled in Figure A1): (a) on-site (modality OS), (b) remote on-screen with interaction (modality R+I), (c) remote without interaction through livestream (modality R-I), or (d) asynchronous through a course recording. The asynchronous modality was excluded from the analyses for RQ2 and RQ3 because participation in this group was too low to allow for reliable statistical comparisons.

Both the places for on-site participation and for remote participation with interaction (option visible on the screen) were limited to 54 on-site seats and 60 available "seats" on the screens. Within this university context, attendance in class was not required, but strongly encouraged. The courses primarily consisted of theoretical instruction sessions. Both teachers frequently asked oral questions during the sessions, without using polling software. No group work or break-out sessions were integrated in the sessions. As the hybrid lecture hall did not have a ceiling microphone, when on-site students answered questions, this was not audible for remote students, unless the instructor passed on his/her microphone.

Data Collection and Measures

Course Modalities

Upon the conclusion of the fourth session, students were requested to complete a questionnaire in which they were asked first in which course they were enrolled and to specify the modality they chose for participation in each of the four sessions. Students were asked to report their mode of class attendance by selecting from four options. The first option, on-site (OS), was described as attending the class on campus in the same room as the instructor, which involved face-to-face participation. The second option, remote with interaction (R+I), referred to attending the class remotely while being visible on the screens and interacting via the WeConnect learning platform (product no longer available). The third option, remote without interaction (R-I), involved attending the class synchronously from a remote location without being visible on the screens, using livestreaming. Finally, the fourth option, asynchronous viewing (A), pertained to watching a recording of the class at a later time.

Extraversion and Collectivism

We evaluated two specific personality traits: extraversion and collectivism. These facets were measured using the Professional Attitudes Continuum Questionnaire (PACQ; Vrijdags et al., 2020). The PACQ encompasses three categories: personal, interpersonal, and professional, and includes a total of fifteen bipolar dimensions. Participants rated items of these dimensions using a 5-point Likert scale, with each dimension/scale comprising six items. Students were asked to read opposing statements and indicate which one applied most to them. In our study, the scales for independent worker/team player (i.e., collectivism) and introvert/extravert (i.e., Extraversion) were administered and demonstrated internal reliability with Cronbach's α values of .84 and .78 respectively; the McDonald's omega (ω) coefficients further confirmed this reliability with values of .85 for collectivism and .79 for extraversion. An overview of the interpersonal dimensions measured in this study is provided in Table A1 in Appendix A.

Individual Flow

Individual flow was measured once after the fourth course session, using a translated version of the validated EduFlow-2 questionnaire (Heutte et al., 2021). The original scale, provided in French, has been proven to be useful in different environments including both on-site and distance learning modalities in adult education. It includes four dimensions (cognitive control, immersion and time transformation, loss of self-consciousness, and autotelic experience), each based on three items which were scored on a 7-point Likert scale. Flow is measured by averaging the different dimensions. Since our current participants were Dutch-speaking, it was necessary to provide a translated version of this questionnaire. Table A2 provides an overview of the flow dimensions and questionnaire items. The statistics for item reliability based on our data are presented in Table B1 and Pearson's correlations among the flow dimensions are presented in Table B3.

Data Analysis

Data analysis for this study was done in R (version 4.3.1). To study RQ1.1, a Sankey plot was designed using the ggsankey package (Sjoberg, 2021). Sankey plots allow visualization of the course modality transitions, tracking changes over time. Similarly, for RQ1.2, a Sankey plot was designed for each of the specific courses in order to facilitate the comparison of student transitions across the different modalities.

To investigate research question RQ2, the choices corresponding to the fourth condition, i.e., asynchronous learning through course recordings, were treated as missing values in our analysis, because they were not relevant to the second research aim. We performed two distinct multilevel logistic regression analyses. First, we examined students' choice of modality across four sessions, distinguishing between on-site (coded as 1) versus remote (coded as 0) modalities. Second, we explored variations in modality choices by considering remote modalities with (coded as 1) and without (coded as 0) interaction. Across both models, we included personality facets (i.e., extraversion and collectivism) and course as predictor variables. Additionally, we controlled for gender and session number (1 to 4). The logistic regression models were estimated using the glmer function from the lme4 package in R (Bates et al., 2015). The optimization method employed was bobyqa, and we set the number of adaptive Gauss-Hermite quadrature points to 10.

To study RQ3.1, multiple regression analyses were performed for each of the flow dimensions. Specifically, the flow dimensions were regressed on the modality choice in the fourth session, the personality facets (i.e., extraversion and collectivism) and gender. In addition, interaction effects were added between the predictors. In all these models, we controlled for gender and course.

Results

Student Transitions Between Different Course Modalities Across the Sessions

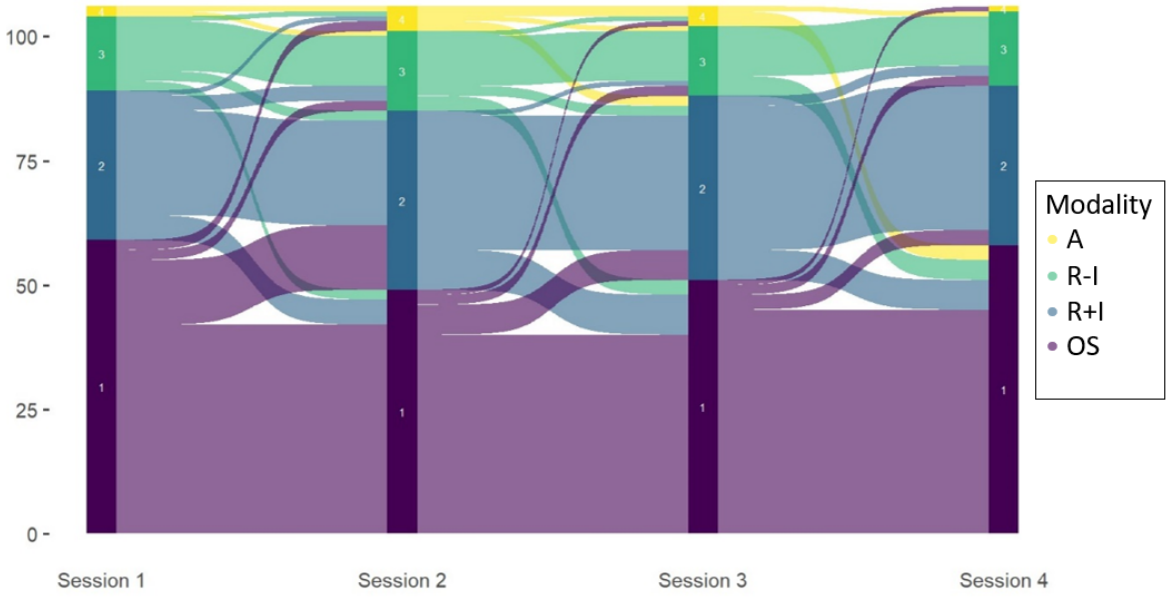
RQ1.1 aimed at unravelling students' choices for a course modality over the time (i.e., sessions). Table C1 presents the distribution of students per modality across the different sessions. Overall, in the full sample, we see that modality OS (46% to 56%) and modality R+I (28% to 35%) were the most popular choices across all sessions. Modality R-I (13% to 15%) and modality A (1% to 5%) have much lower frequencies. The data presented in Figure 1, which

delineates the transitions of students across various modalities and sessions shows a substantial shift of students from modality OS primarily towards modality R+I. This shift partially accounts for the decrease in students choosing modality OS, from 56% in session 1 to 46% in session 2, and the corresponding increase in students opting for modality R+I, from 28% to 34%. However, by session 4, the trend reversed. The proportion of students in modality OS rebounded to 55%, while the percentage of students in modality R+I receded to 30%. This suggests that students' modality preferences evolved throughout the course.

With RQ1.2, we aimed at unravelling potential differences in modality selections and transitions across the students participating in course 1 (first year bachelor's students) and those participating in course 2 (second year bachelor's students). The data presented in Table C2 and the visual representations of student flows across the different modalities for course 1 (see Figure 2) and course 2 (see Figure 3) show that the relative frequency of students participating in course 2 through modality R-I (0% to 6%) is much lower compared to the relative frequencies of this modality in course 1 (18% to 21%). Conversely, the relative frequency of students in modality R+I was systematically higher in course 2 (37% to 46%) compared to course 1 (25% to 34%).

Figure 1

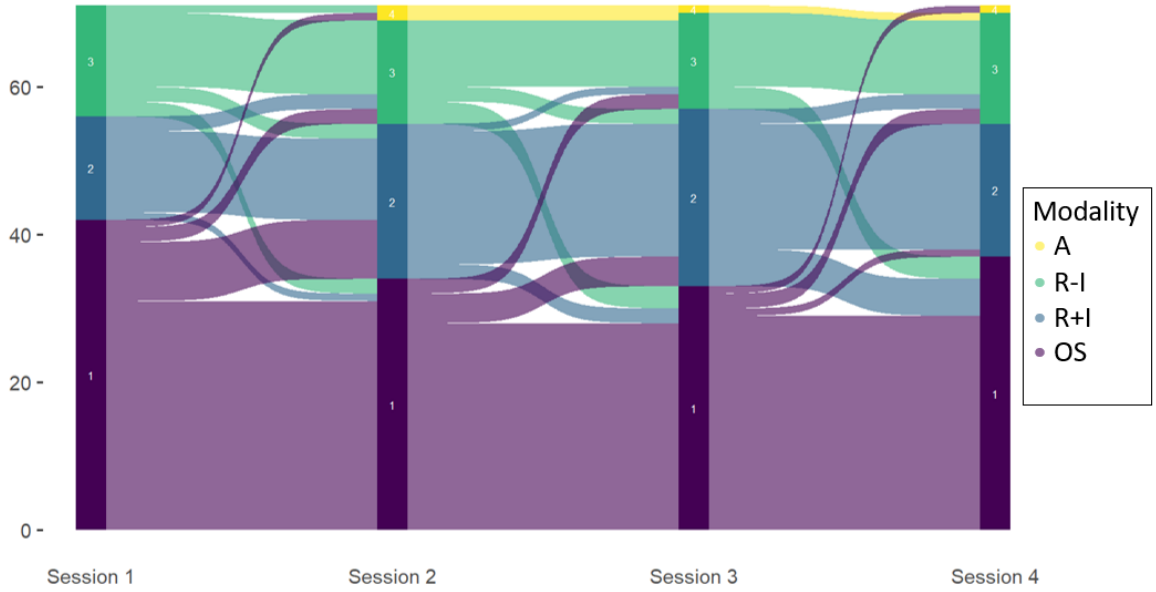
Transitions Between the Course Modalities Across the Sessions for the Full Sample



Note. This Sankey plot illustrates students' transitions between modalities across four sessions. Each horizontal bar represents the number of students by modality in a given session. The height of the bar segments corresponds to the number of students in that modality. The flows between the bars depict transitions between modalities across sessions. The vertical axis shows the absolute number of students. A = asynchronous; R-I = remote without interaction; R+I = remote with interaction; OS = on-site.

Figure 2

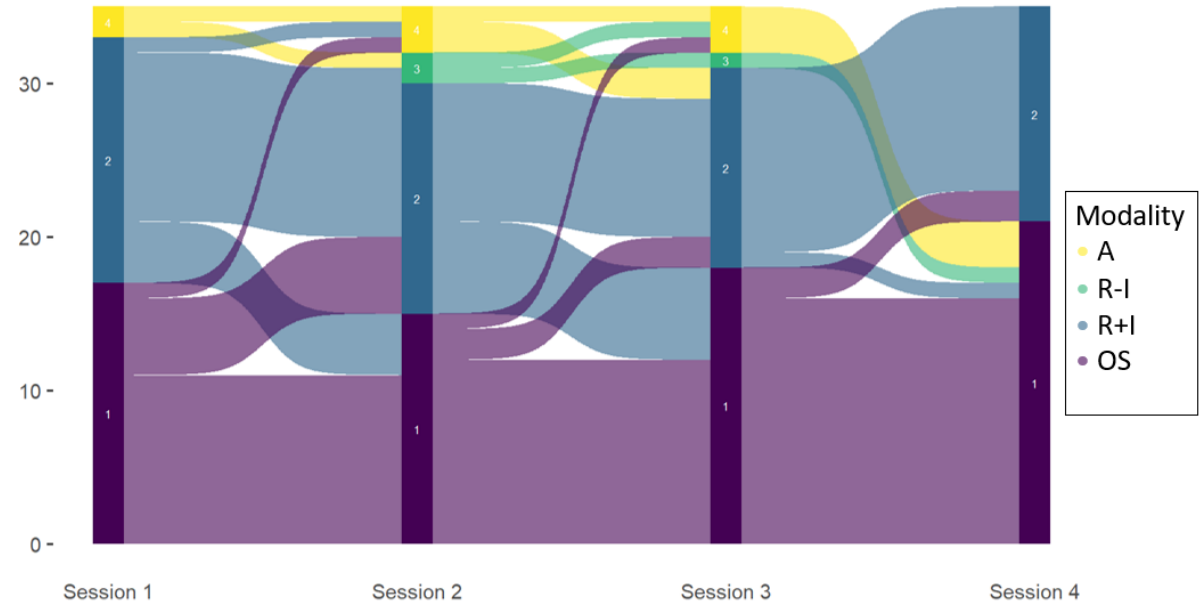
Transitions Between the Course Modalities Across the Sessions for Students in Course 1 (First Year Bachelor's Students)



Note. The vertical axis shows the absolute number of students. Course 1 = first-year bachelor's students. A = asynchronous; R-I = remote without interaction; R+I = remote with interaction; OS = on-site.

Figure 3

Transitions Between the Course Modalities Across the Sessions for Students in Course 2 (Second Year Bachelor's Students)



Note. The vertical axis shows the absolute number of students. Course 2 = second-year bachelor's students. A = asynchronous; R-I = remote without interaction; R+I = remote with interaction; OS = on-site.

Personality and Students' Choice of Modality

RQ2 sought to unravel how the personality traits of extraversion and collectivism influence students' choice of modality. We hypothesized (H2.1) that students scoring higher on extraversion and collectivism would be more likely to participate in the course from the on-site setting compared to the remote setting.

Prior to the analyses, we performed an in-depth examination of the descriptive statistics of our variables (see Annex A). Furthermore, we evaluated the suitability of a multilevel model for the data analyses, and as such we performed a model comparison test. This test compared a single-level null model to a multilevel null model, aiming to determine the most appropriate model for our analysis. The $\chi 2$ test yielded a significant result, $\chi 2(423) = 587.55$, $p < .001$, indicating that the model fits the data significantly better than a null model. Further preliminary analyses revealed no issues of multicollinearity among the predicting variables.

The results of the multilevel logistic regression analysis, in which students' choice of modality was regressed on their personal characteristics (i.e., extraversion and collectivism) controlling for gender, the course, and the session, are presented in Table 1. In line with the hypothesis (H2.1), the results revealed a significant effect of extraversion, indicating that students scoring higher on extraversion were more likely to participate in the course from the on-campus setting compared to the remote setting. Conversely, more introvert students prefer the remote setting compared to the on-campus setting. However, the effect for collectivism was not significant.

Table 1

Results of the Multilevel Logistic Regression Analysis of On-Site Modality Versus Remote Modality Choice

	On-site (1) vs. remote (0)			With (1) vs. without (0) interaction		
Predictors	*Odds Ratio*	*CI*	*p*	*Odds Ratio*	*CI*	*p*
Intercept	1.41	0.23 – 8.82	.71	156.28	0.06 – 393696.44	.21
Extraversion	2.87	1.10 – 7.50	**.03**	5.11	0.11 – 238.95	.41
Collectivism	1.12	0.44 – 2.88	.81	0.05	0.00 – 2.30	.12
Random effects						
σ^2	3.29			3.29		
$\tau_{00\ ID}$	11.39			108.83		
ICC	0.78			0.97		
N_{ID}	106			70		
Observations	412			195		
Marginal R^2 / Conditional R^2	0.062 / 0.790			0.052 / 0.972		

Note. In line with recommendations of Hünermund and Louw (2023) coefficients of control variables (i.e., gender, session, and course) are omitted from this regression table. Significant *p*-values are marked in bold. CI = confidence interval; ICC = intraclass correlation coefficient.

The second hypothesis for this research question (H2.2) stated that students in the remote modality, scoring higher on extraversion and collectivism, would be more likely to choose the modality with interaction (modality R+I). To assess this hypothesis, again logistic regression was used, looking specifically into modality R+I and modality R-I. An initial examination of the data revealed a notably low relative frequency of students in course 2 opting for modality R-I. Therefore, course was not included as a variable in the regression model for this specific hypothesis. Next, the initial $\chi 2$ test, conducted to evaluate the appropriateness of a multilevel model, yielded a significant result once more: $\chi 2(194) = 240.72$, $p < .001$. Results of the multilevel logistic regression analysis are presented in Table 1. The findings indicate that neither extraversion nor collectivism significantly influenced the students' choice in the remote modality. In other words, for students in the remote condition, their levels of extraversion and collectivism did not have a significant impact on their preference for participating in an interactive or non-interactive manner.

Students' Choice of Modality and Their Flow Experience

RQ3 aimed at unravelling whether the modality of participation in a course influenced students' flow experience. We hypothesized that (H3.1.1) students participating on-site would experience higher levels of flow compared to those participating remotely and (H3.1.2) students participating remotely with interaction experience higher levels of flow compared to students participating remotely without interaction. To assess these hypotheses, the different flow variables (i.e., flow, cognitive control, immersion and time transformation, loss of self-consciousness, and autotelic experience) were regressed on the variable modality. In these models, we also controlled for gender and course and the two personality dimensions. In an additional model (i.e., model 2), interactions between modality and the personality variables were added to the analyses to assess H3.2, i.e., whether students scoring higher on extraversion and collectivism would experience higher levels of flow in social (with interaction) course modalities, meaning those with interaction. In what follows we discuss the results of these regression analyses for overall flow and for the individual flow dimensions.

Flow

As presented in Table 2, the effect of modality approached significance in the model without interaction effects ($F_{2,98} = 2.93$, $p = .06$). However, in the model with interaction effects (model 2), the effect of modality was significant ($F_{2,94} = 2.93$, $p = .04$). To further examine the differences in flow between the modalities, subsequent Tukey's HSD (honestly significant difference) post-hoc comparisons were performed. Pairwise comparisons indicated that flow measurements between modality OS (least squares $M = 4.52$) and modality R-I (least squares $M = 3.88$) were significantly different ($p = .03$). However, no significant differences were observed between modality OS and modality R+I (least squares $M = 4.44$), nor between modality R+I and modality R-I.

The effect of extraversion was significant in the model without interaction effects ($F_{1,98} = 8.68$, $p < .001$). However, when interaction effects were added to the model, the effect of extraversion approached significance ($F_{1,94} = 3.28$, $p = .06$). The effect of collectivism was not significant in any of the models. Furthermore, the results showed no significant interaction effects between the personality traits and modality.

Table 2

Results of the Regression Analyses for the Effects of Modality (Model1) and Extraversion and Collectivism (Model 2) on Flow

Variable	Model 1				Model 2			
	SS	*df*	*F*	*p*	SS	*df*	*F*	*p*
Intercept	324.56	1	535.99	**< .001**	316.25	1	523.98	**< .001**
Modality	3.54	2	2.93	.06	3.97	2	3.28	**.04**
Extraversion	5.26	1	8.68	**< .001**	2.27	1	3.77	.06
Collectivism	0.47	1	0.78	.38	0.5	1	0.83	.36
Extraversion*modality					2.31	2	1.91	.15
Collectivism*modality					0.42	2	0.35	.71
Residuals	59.34	98			56.73	94		

Note. In line with recommendations of Hünermund and Louw (2023) coefficients of control variables (gender and course) were omitted from this table. Significant *p*-values are marked in bold. *SS* = sum of squares.

Cognitive Control

The effect of modality was significant in both models (see Table 3), model 1 (F(2, 98) = 3.43, *p* = .04) and model 2 (F(2, 98) = 4.38, *p* = .02). For model 1, a post hoc Tukey test showed non-significant differences between modality OS and R+I and modality OS and R-I, but significant differences between modality R+I and R-I (*b* =0.88, *p* = .04). For model two, again, only a significant difference was found between modality R+I and R-I (*b* = 1.05, *p* = .02). Extraversion and collectivism showed no significant association. Last, the interaction effects between extraversion and modality, as well as collectivism status and modality, were not statistically significant.

Table 3

Results of the Regression Analyses for the Effects of Modality (Model 1) and Extraversion and Collectivism (Model 2) on Cognitive Control

Variable	Model 1				Model 2			
	SS	*df*	*F*	*p*	SS	*df*	*F*	*p*
Intercept	317.51	1	272.93	**< .001**	337.15	1	295.16	**< .001**
Modality	7.98	2	3.43	**.04**	10	2	4.38	**.02**
Extraversion	10.24	1	8.8	**< .001**	3.89	1	3.41	.07
Collectivism	0.15	1	0.13	.72	1.17	1	1.03	.31
Extraversion*modality					5.25	2	2.3	.11
Collectivism*modality					2.83	2	1.24	.29
Residuals	114.01	98			107.37	94		

Note. In line with recommendations of Hünermund and Louw (2023), coefficients of control variables (gender and course) were omitted from this table. Significant *p*-values are marked in bold. *SS* = sum of squares.

Immersion and Time Transformation

There was no significant effect of modality on Immersion and time transformation (as displayed in Table 4). Additionally, neither extraversion nor collectivism showed a significant impact. Furthermore, no significant interaction effects were observed.

Table 4

Results of the Regression Analyses for the Effects of Modality (Model 1) and Extraversion and Collectivism (Model 2) on Immersion and Time Transformation

Variable	Model 1				Model 2			
	SS	*df*	*F*	*p*	SS	*df*	*F*	*p*
Intercept	283.67	1	347.83	**< .001**	287.81	1	358.92	**< .001**
Modality	2.23	2	1.37	.26	2.04	2	1.27	.28
Extraversion	1.55	1	1.90	.17	0.79	1	0.98	.32
Collectivism	0.01	1	0.01	.93	0.18	1	0.23	.63
Extraversion*modality					1.24	2	0.77	.46
Collectivism*modality					1.97	2	1.23	.30
Residuals	79.92	98			75.38	94		

Note. In line with recommendations of Hünermund and Louw (2023), coefficients of control variables (gender and course) were omitted from this table. Significant *p*-values are marked in bold. *SS* = sum of squares.

Loss of Self-Consciousness

As presented in Table 5, a significant effect of gender was observed in both model 1 ($F(1, 98) = 4.53$, $p = .04$) and model 2 ($F(1, 94) = 4.15$, $p = .04$). However, there was no significant effect of modality in either model. Additionally, neither extraversion nor collectivism had a significant main effect on the outcome. Furthermore, no significant interaction effects were found.

Table 5

Results of the Regression Analyses for the Effects of Modality (Model1) and Extraversion and Collectivism (Model 2) on Loss of Self-Consciousness

Variable	Model 1				Model 2			
	SS	*df*	*F*	*p*	SS	*df*	*F*	*p*
(Intercept)	380.19	1	154.15	**< .001**	376.38	1	148.14	**< .001**
Modality	6.05	2	1.23	.3	4.17	2	0.82	.44
Extraversion	7.51	1	3.04	.08	6.2	1	2.44	.12
Collectivism	2.44	1	0.99	.32	1.04	1	0.41	.52
Extraversion*Modality					1.38	2	0.27	.76
Collectivism*Modality					0.92	2	0.18	.83
Residuals	241.7	98			238.82	94		

Note. In line with recommendations of Hünermund and Louw (2023), coefficients of control variables (gender and course) were omitted from this table. Significant *p*-values are marked in bold. *SS* = sum of squares.

Autotelic Experience

Regarding autotelic experience, a significant effect of modality was observed in both models (see Table 6). Post hoc analyses revealed a significant difference between modality OS and modality R-I for both model 1 (b = 0.82, p = .04) and model 2 (b = 0.95, p = .02), where students in modality OS scored significantly higher on autotelic experience compared to students in modality R-I.

Table 6

Results of the Regression Analyses for the Effects of Modality (Model1) and Extraversion and Collectivism (Model 2) on Autotelic Experience

Variable	Model 1				Model 2			
	SS	*df*	*F*	*p*	SS	*df*	*F*	*p*
Intercept	320.48	1	267.85	**< .001**	269.17	1	234.13	**< .001**
Modality	10.81	2	4.52	**.01**	11.69	2	5.08	**.01**
Extraversion	3.94	1	3.29	.07	0.47	1	0.41	.53
Collectivism	0.76	1	0.64	.43	1.34	1	1.17	.28
Extraversion*modality					8.43	2	3.67	**.03**
Collectivism*modality					1.63	2	0.71	.50
Residuals	117.26	98			108.07	94		

Note. In line with recommendations of Hünermund and Louw (2023), coefficients of control variables (gender and course) were omitted from this table. Significant *p*-values are marked in bold. *SS* = sum of squares.

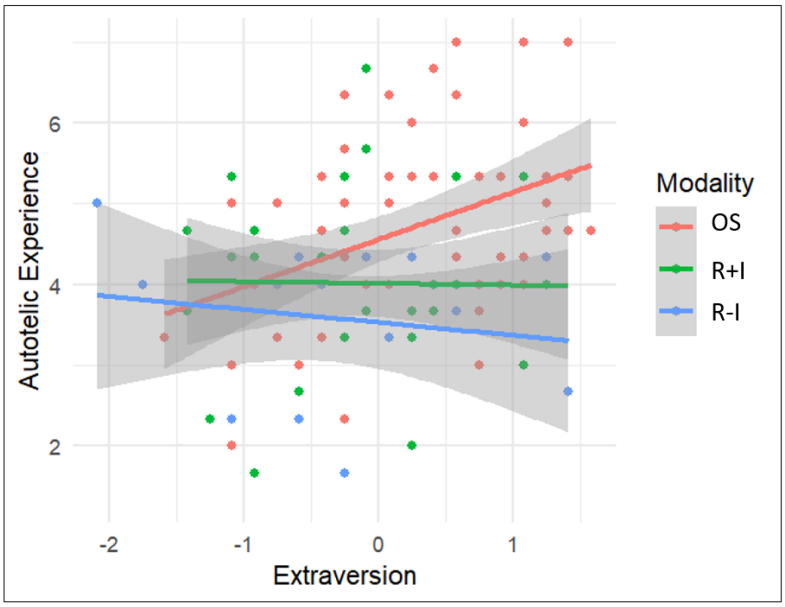
There was no significant main effect for extraversion or collectivism. However, a significant interaction effect was found between extraversion and modality (p = .03). Specifically, post-hoc analysis indicated that the relationship between extraversion and autotelic experience significantly differed between students in modality R-I compared to modality OS (see Figure 4).

Discussion

Thanks to technological evolutions, as indicated by Irvine (2020), the landscape of online learning has evolved over time as online learning used to refer to text-based, asynchronous *anytime-anyplace-anywhere* courses. Nowadays, online learning can also refer to being connected with face-to-face students from a remote location meaning that access to education is created through different modalities, conceptualized as multi-access education (Irvine, 2009). However prior research shows that different modalities have different characteristics resulting in different learning outcomes (Raes, 2022). The overall objective of this study was to investigate to what extent multi-access education can provide opportunities for more inclusive and personalized higher education (Pelletier et al., 2023; UNESCO, 2020). In the following sections, we elaborate on each of the research findings, discussing them in relation to the respective hypotheses and providing insights into the observed patterns and implications.

Figure 4

Visualization of the Interaction Effect Between Modality and Extraversion



Note: OS = on-site; R+I = remote with interaction; R-I = remote without interaction.

Modality Transitions

First, we aimed to get insight into student choice behaviour regarding course modality and to what extent this changed over time in the context of multi-access education. Interestingly, most modality alternations could be observed between the first and second session and the third and fourth session of the course. To a smaller extent, modality alternations could be observed between the second and third sessions. Additionally, we observed differences in students' modality selections between the two courses which differed in audience (first- versus second-year bachelor's students) and teacher. Specifically, major differences in participation for the remote modality without interaction could be observed. Students in the second-year bachelor's course had lower participation rates in this modality and slightly higher participation rates in the asynchronous modality compared to students in the first-year bachelor's course. The observed differences might be explained by course-specific aspects, such as the course content and the teaching style. The teacher in the first-year bachelor course highly relied on student-teacher interaction to teach using subject-specific legal and subject-domain-related terminology with precision during discussions in the context of law of obligations. With this aim in mind, the teacher often gave the floor to someone remote, but visible on the screen, as then the answer was audible for all students, remote and on-site. Next, it is also important to note the differences in student profiles among the two courses. Specifically, students in the first course were first-year bachelor's students and students in the second course were second-year bachelor's students. For first-year students, publicly answering questions in a lecture hall, unprepared, can be experienced as intrusive. Besides, second-year bachelor's students started at the university in a pre-COVID period (academic year 2019-2020). These students might have been more acquainted with the teacher, the infrastructure, and the other students participating in the course, compared to the first-year bachelor's students. However, external factors such as changes in students' personal schedules or specific circumstances (e.g., being a regular or working student) could also have influenced their modality choices throughout the course. Our

findings support prior work by Gruppen et al. (2019) that indicate learning environments are 'living systems' characterized by interactions across psychosocial dimensions.

Interpersonal Personality Traits and Students' Choice

Second, the research aimed to unravel students' choice of modality based on two interpersonal personality traits—extraversion and collectivism—considering the potential effect of gender and course. First, we hypothesized that (H2.1) students scoring higher on extraversion and collectivism would be more likely to participate in the course from the on-campus setting compared to the remote setting. The results of this study partially supported this hypothesis which is based on previous research (e.g., Zeng & Bridges, 2022, 2023). Specifically, the results underscore that extraversion, characterized by outgoingness and sociability (Augustine & Hemenover, 2012), may incline students towards on-campus settings where social interaction is more prevalent. Our results also show that introverted students prefer the remote setting compared to the on-campus setting indicating that remote participation can also be a positive and deliberate choice, probably more aligned with students' personal needs. This is an important result in light of today's focus on digital personalized learning (Van Schoors et al., 2021) and neurodiversity (Chapman, 2020) offering students autonomy to choose a mode of participation in class that best fits their personality and information-processing activity. Our results are in line with Mentzer et al. (2025) showing higher satisfaction of students' basic psychological needs in multi-access education compared to fully face-to-face instruction. Regarding the collectivism personality trait, our results did not support the hypothesis that team- or individually-oriented people chose more, or less, for on-site participation. This personality trait, originally named independent worker/team player, reflects the extent to which people consult others, involve others, and seek collaboration (Vrijdags et al., 2020). A possible reason for the non-significant effect regarding collectivism might be related to the courses' nature. Specifically, neither of the courses provided major opportunities for collaboration among students, and the educational model used was rather teacher centred. Liu and Csikszentmihalyi (2020) showed that the type of learning activities is an important factor to take into account when questioning the impact of personality and flow experience.

Modality and Flow Experience

Third, this study aimed to investigate the influence of course modality (on-site versus remote, with or without interaction) on students' flow experiences. In line with this research aim, we studied the relationship of interpersonal personality traits and students' flow experience, based on the specific setting. Specifically, we hypothesized that (H3.1.1) students participating in on-site courses would experience higher levels of flow compared to those participating remotely. The results of our study provide partial support for this hypothesis. Students participating through the on-site modality experienced higher levels of flow compared to students participating remotely without interaction, but not compared to students participating remotely with interaction. Next, the analyses on the dimension level of flow revealed that students in the on-site modality experienced higher levels of autotelic experience compared to students in both remote modalities. No significant difference was found between these modalities for the three other flow dimensions—cognitive control, immersion and time transformation, and loss of self-consciousness. Previous research conducted by Wagner et al. (2023) has shown that students in on-site modalities experience higher levels of social presence compared to remote students. When students report higher levels of social presence, they may feel more connected and engaged with the learning environment, which may in turn enhance flow experiences. The relationship between social presence and flow has been tested in the context of games by

Wang and Lee (2020). They found that perceived social presence positively predicted participants' reported level of perceived enjoyment and concentration as dimensions of flow.

Next, we hypothesized that (H3.1.2) students participating remotely with interaction would experience higher levels of flow compared to students participating remotely without interaction. This hypothesis was only mildly supported. Specifically, our analyses revealed no significant difference in students' flow experience. However, looking into the difference for the dimensions of flow, a significant difference was found for cognitive control. Students in the remote modality with interaction reported a higher level of cognitive control compared to students in the remote modality without interaction. Cognitive control represents the individual's ability to manage their cognitive processes, maintain focus, and engage in deliberate practice, all of which contribute to the experience of flow (Heutte et al., 2016; Peifer & Tan, 2021). A possible explanation for the difference observed regarding cognitive control, could be that students in the modality without interaction, who were not visible on the displays in the lecture hall, were more easily distracted compared to students in the condition with interaction. It could also be that students in the course modality with interaction experienced higher levels of social presence, which in turn influenced their cognitive control (Wagner et al., 2023; Wang & Lee, 2020), as discussed above.

Furthermore, based on previous literature on flow proneness and autotelic personality, we hypothesized that (H3.3) students scoring higher on extraversion and collectivism would experience higher levels of flow in the course modalities with interaction. The results of our research partially support this hypothesis. Whilst no significance was found for flow, a significant effect was found for one of the dimensions of flow, i.e., autotelic experience. Students in the on-site condition who were more extraverted reported higher levels of autotelic experience. This relationship was weaker in the remote conditions. This result supports the idea that the link between personality and flow experience is moderated by the context of the learning environment (Liu & Csikszentmihalyi, 2020). Yet, as indicated above more profound results could be expected during social learning activities like groupwork.

Limitations

This study has several limitations that must be acknowledged. The generalizability of the findings is constrained by some sample and context characteristics. For instance, this research took place in the context of two specific courses in a single institution using the same infrastructure and technology. In addition to the overrepresentation of female participants in the sample, this limits the applicability of the findings to broader populations and diverse educational contexts. Furthermore, the study was conducted during the COVID-19 pandemic, which likely influenced students' modality preferences and overall learning experiences. The unique circumstances of this period, including social distancing requirements and the rapid transition to hybrid learning models, may not fully represent post-pandemic settings. The generalizability of the results to post-pandemic educational environments remains uncertain.

In addition, the analysis was limited to four sessions per course, which provides a snapshot of students' choices and experiences but may not capture longer-term trends or shifts in behaviour. The study did not include the asynchronous modality in some of the analyses due to low participation rates for this group. Differences in pedagogical approaches (e.g., teacher-student interaction, content delivery) may also have impacted the results. Such differences were not systematically examined, leaving room for future research to explore this. Lastly, the study solely relied on self-report measures to assess flow and two personality traits. It did not account

for other individual differences among students, such as additional personality characteristics and students' prior experience with the various modalities or their broader academic history, which could have influenced their modality choices and flow experiences. More specifically, quasi-experimental set-ups would provide insight into potential aptitude treatment effects in different pedagogical settings.

Recommendations

Building on the exploratory nature of this study, future research should aim to address its limitations and expand our understanding of student behaviour in multi-access education. The current study could be directly or conceptually replicated. Exploring diverse educational contexts (i.e., different faculties and disciplines) and incorporating various technological infrastructures (e.g., different online environments for remote students) could offer a more comprehensive understanding. Future research could aim to include a more balanced representation of participants across all modalities, including the asynchronous mode. Additionally, examining courses with distinct pedagogical designs, including those emphasizing collaborative activities and varied levels of student-teacher interaction, would help clarify how instructional approaches interact with modality to influence flow and engagement. Future research designs could also extend beyond the short timeframe of four sessions to capture longer-term trends and shifts in students' modality choices and flow experiences.

While this study controlled for gender and focused on two personality traits (i.e., extraversion and collectivism), future research could broaden its scope to include a broader range of student characteristics. For instance, incorporating additional personality traits from the five-factor model (see McCrae & Costa, 2008a) would provide a more nuanced understanding of how diverse personality profiles influence modality choices and flow experiences. Moreover, adopting a neurodivergent lens (Chapman, 2020) could offer critical insights into how students with different cognitive processing styles or neurodivergent traits engage within different course modalities, thereby promoting more inclusive educational practices. In addition, future research could examine students' learning strategies, which have been shown to influence preferences for specific learning environments (Clayton et al., 2010; O'Neill et al., 2021). Socio-economic status and practical considerations, such as the distance between a student's residence and the campus, are also critical variables to consider, as they may impact both modality choice and engagement (McPartlan et al., 2021). Furthermore, exploring students' prior experiences with hybrid modalities could help contextualize their preferences, behaviours, and flow experiences within these settings. Including these perspectives in future research could offer actionable insights into the design of multi-access education that meets the needs of a wider range of learners.

Lastly, given the reliance on self-report measures in this study, future research could integrate alternative methods, such as behavioural data, physiological indicators, log data, or observational measures, to complement self-report measures. Incorporating additional data types would enable an analysis of the extent to which students interact and communicate with one another across different modalities.

Conclusion

This research underscores the need to take individual differences into account when studying the effectiveness of new technologies in education. Our results show that conclusions about the impact of multi-access education combining different modalities cannot be drawn based on

comparing remote versus on-site experiences. By just comparing these experiences, we would also conclude that remote education is inappropriate due to lower affective learning outcomes. However, taking into account students' personalities, it appears that introverted students deliberately chose remote education. In this respect, our study contributes to the research on personalized learning, showing that next to personalization of what and how students learn (Bernacki et al., 2021), current technological evolutions and the changing educational landscape can nowadays also provide a choice about where students learn (Irvine, 2020), creating a new dimension of adaptivity in digital personalized learning (Van Schoors et al., 2021).

Author's Contributions

Annelies Raes was the Project Coordinator and responsible for the study design, the ethical approval and the data collection. Siem Buseyne conducted the data analyses. The authors collaboratively wrote all sections of the paper, from the theoretical framework to the discussion.

Open Researcher and Contributor Identifier (ORCID)

Siem Buseyne https://orcid.org/0000-0003-2183-8809
Annelies Raes https://orcid.org/0000-0001-9237-9385

Ethics Statement

This research has been evaluated and approved by the Social and Societal Ethics Committee of KU Leuven (G- 2018 06 1264).

Conflict of Interest

The authors do not declare any conflict of interest.

Data Availability Statement

Inquiries regarding access to the data used in this study can be directed to the corresponding author.

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Appendix A

This appendix presents the hybrid lecture hall used for this study (See Figure A1).

Figure A1

Visualization of the Hybrid Lecture Hall Providing Students With Three Synchronous Delivery Modes

Table A1

Overview of the Interpersonal Dimensions Measured in This Study.

Collectivism	Independent worker		Team player
Description	Works independently on his/her own and seeks out tasks that he/she can perform alone		Consults others, involves others, seeks collaboration.
Example item (1 out of 6 items)	I prefer to work alone.	o o o o o	I prefer to work in a team.
Extraversion	**Introvert**		**Extrovert**
Description	Needs time to feel at ease, is comfortable in familiar situations and/or with people who he/she knows; prefers to stay in the background when in a group		Is open and feels at ease quickly; is comfortable in unfamiliar situations and/or with people whom he/she does not know, is spontaneous, likes to be centre stage.
Example item (1 out of 6 items)	I prefer to stay in the background in a group.	o o o o o	I like to be the centre of attention.

Note. These items were translated from Dutch. The middle dot indicates no preference for either statement.

Table A2

Overview of the Flow Dimensions and Items

Cognitive control
1. I feel capable of meeting the high expectations of the situation.
2. I feel that I have full control over what I am doing.
3. I know exactly what to do at every step.
Immersion and Time transformation
1. I am completely absorbed in what I am doing.
2. I am very focused on what I am doing.
3. I lose track of time.
Loss of self-consciousness
1. I am not worried about what others might think of me.
2. I am not concerned about the judgment of others.
3. I don’t care what others might think of me.
Autotelic experience
1. I feel like I am experiencing an enthusiastic moment.
2. This activity gives me a sense of well-being.
3. When I talk about this activity, I feel a strong emotion that I want to share.

Appendix B

Table B1

Descriptive Statistics of the Flow Variables and Items

Dimension & Item	*M*	*SD*	Chronbach's *α*	McDonald's *ω*
Flow (based on the 12 items below)	4.33	0.85	.79	.80
Cognitive control	4.38	1.16	.79	.79
1. I feel capable of meeting the high expectations of the situation.	4.45	1.36		
2. I feel that I have full control over what I am doing.	4.25	1.52		
3. I know exactly what to do at every step.	4.42	1.27		
Immersion and time transformation	4.46	0.92	.36	.52
1. I am completely absorbed in what I am doing.	4.48	1.43		
2. I am very focused on what I am doing.	4.53	1.36		
3. I lose track of time.	4.26	1.35		
Loss of self-consciousness	4.23	1.63	.87	.88
1. I am not worried about what others might think of me.	4.31	1.88		
2. I am not concerned about the judgment of others.	4.13	1.78		
3. I don't care what others might think of me.	4.25	1.82		
Autotelic experience	4.27	1.20	.69	.73
1. I feel like I am experiencing an enthusiastic moment.	4.20	1.65		
2. This activity gives me a sense of well-being.	4.62	1.47		
3. When I talk about this activity, I feel a strong emotion that I want to share.	3.99	1.44		

Table B2

Descriptive Statistics of the Personality Variables

Variable	***M***	***SD***	**Min**	**Max**
Extraversion	3.08	0.83	1	4.67
Collectivism	2.49	0.85	1	4.33

Note. The scale ranged from 1 to 5.

Table B3

Pearson's Correlations Among the Flow Dimensions

Dimension	Flow	Cognitive control	Immersion and time transformation	Loss of self-consciousness	Autotelic experience
Flow	1.00	.77	.53	.70	.73
Cognitive control	.77	1.00	.28	.38	.47
Immersion and time transformation	.53	.28	1.00	.05	.39
Loss of self-consciousness	.70	.38	.05	1.00	.23
Autotelic experience	.73	.47	.39	.23	1.00

Appendix C

Table C1

Relative Frequency of Students per Modality Across the Different Sessions

Modality	Distribution of students per session (%)			
	1	2	3	4
Modality OS – on-site	56	46	48	55
Modality R+I – remote with interaction	28	34	35	30
Modality R-I – remote without interaction	14	15	13	14
Modality A – asynchronous recording	2	5	4	1

Table C2

Relative Frequency of Students per Modality Across the Different Sessions per Course

Modality	Session			
	1	2	3	4
	Distribution of students in Course 1 (%)			
OS	59	48	46	52
R+I	20	30	34	25
R-I	21	20	18	21
A	0	3	1	1
	Distribution of students in Course 2 (%)			
OS	49	43	51	60
R+I	46	43	37	40
R-I	0	6	3	0
A	6	9	9	0

Note. OS = on-site; R+I = remote with interaction; R-I = remote without interaction; A = asynchronous recording.