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Hybrid learning environments in higher education: A systematic review of emerging learning and teaching modalities

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Abstract

Since the onset of the pandemic, hybrid learning environments have seen significant expansion to cater to diverse learning preferences across different domains. As educators become more familiar with these settings, they encounter challenges and opportunities. Hybrid learning must meet the needs of both in-person and remote students, ensuring fair access to educational outcomes. Our review reveals varied experiences among teachers adapting to these technologies and methods. From students' perspective, hybrid learning enhances autonomy and self-directed learning as they navigate in-person and online modalities. It suggests that personal dispositions significantly impact student engagement more than peer interactions. Educators also need additional academic development opportunities to adapt curricula for hybrid delivery. Future research should continue to explore how to better support educators and students in these settings, focusing on optimising design principles for hybrid learning, enhancing digital tool integration, and developing personalised learning paths to accommodate diverse students and improve learning outcomes.

Keywords: Hybrid learning, Lecturers' perceptions, Students' experiences, Hybrid design, Students' behaviours

Introduction

The global pandemic in 2020 fundamentally transformed how people live, work, and learn. Higher education institutions (HEIs) were forced to adapt rapidly during this period by reducing classroom occupancy to facilitate social distancing and employing web conferencing tools for synchronous learning (Benitz, 2021; Brown & Tenbergen, 2021). As the pandemic subsided, HEIs continued innovating in virtual learning by finding ways to enable on-campus and off-campus students to participate in classes simultaneously. This



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approach, commonly referred to as hybrid learning, has also been termed as synchronous hybrid, blended synchronous learning, and blended learning (Akkoyunlu & Soyulu, 2006; Bower et al., 2014; Lightner & Lightner-Laws, 2016; Raes et al., 2019). There appears to be vibrant uptake of this teaching strategy, but its implementation is not without challenges. Teaching staff reported difficulties in catering to both in-person and remote students while there are also challenges with using technological tools to facilitate interaction between these two groups (Bower et al., 2015; Wang et al., 2018). Additionally, issues surrounding student assessment and increased workload were also raised by recent studies (Li et al., 2023; Li et al., 2024).

The prevalence of multiple nomenclatures of this emerging learning modality makes it challenging to consolidate existing research on hybrid learning. For example, blended learning generically refers to the blending of online, e-learning activities and traditional classroom strategies. However, it could also encompass blended synchronous learning whereby synchronous learning between different student groups – remote and in-person students – has taken place through the aid of web-conferencing tools (Bower et al., 2015). This learning modality has also been referred to as Hybrid Learning in research from Vietnam and China (Pham & Pham, 2022; Xiao et al., 2020). This issue of having multiple ways to describe hybrid learning has also been identified by Raes et al. (2019). These many ways of describing hybrid learning add complexity and confusion, while a common framework to guide research of best practices and effective teacher implementation has yet to emerge. While the literature review done by Raes et al. (2019) identified pedagogical benefits of hybrid learning and design guidelines aimed at optimising it, it calls for more thorough investigation into pedagogical challenges and technological constraints (Raes et al., 2019; Zhao, 2023). In addition, as the systematic review was done before the pandemic, and multiple studies pertaining to hybrid learning have been conducted since then, there is a need to consolidate the literature and categorise various instructional designs and their impact on learning outcomes. With the exponential advancement of technology, higher education will continue to be disrupted; hence, it is even more critical to utilise common terminology to describe educational design and teaching practices instead of redefining terms that have already been concretised so that we can further our shared understanding through clear academic discourse (Irvine, 2020).

This paper treats hybrid learning as synchronous learning where students attend learning activities simultaneously in-person and remotely (La Rosa & Mavroudi, 2022). In such setups, students are engaged synchronously through web-conferencing tools, aided by various online collaborative tools and platforms (Raes, 2022). This systematic literature review examines the different understandings of hybrid learning and how they have been implemented in HEIs. It also sought to analyse how learning environments and the design of learning activities influence student learning outcomes and experiences.

The research questions

1. What is the current conception of hybrid learning?
2. How do teaching staff design and implement hybrid learning, and what were their experiences?
3. What are students' learning behaviours in hybrid learning environments (HLEs)?

Methods and procedures

This review employed the Systematic and Tripartite Approach (STA) (Daniel & Harland, 2017). STA enables researchers to employ a systematic and methodical approach to review by providing a descriptive summary of critical issues before categorising and synthesising research that has been reviewed. Within-study and between-study analyses were done to surface issues and experiences from teaching staff and students regarding hybrid learning. The review employed a systematic search of the literature on hybrid learning using the databases Scopus, EBSCO Education Complete and Web of Science (Core Collection) for SSCI and SCI-listed journals. Critical views of the work reviewed were developed, and the implications of the analysis were explained.

Search strategy

The search strings used to locate journal articles with empirical evidence of teaching staff's and/or students' experiences in Hybrid Learning were:

(Higher Education OR college OR university) AND (Hybrid learning OR blended synchronous learning).

The search strings were intentionally kept broad to capture different dimensions of Hybrid Learning. Thereafter, the review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) quality standards to screen and scan abstracts to decide which papers to review. Peer-reviewed papers and conference proceedings from January 2013 to December 2023 written in English were included. This 11-year search period was chosen to compare pre-, during, and post-COVID-19 trends. The other inclusion and exclusion criteria are as follows:

Inclusion criteria:

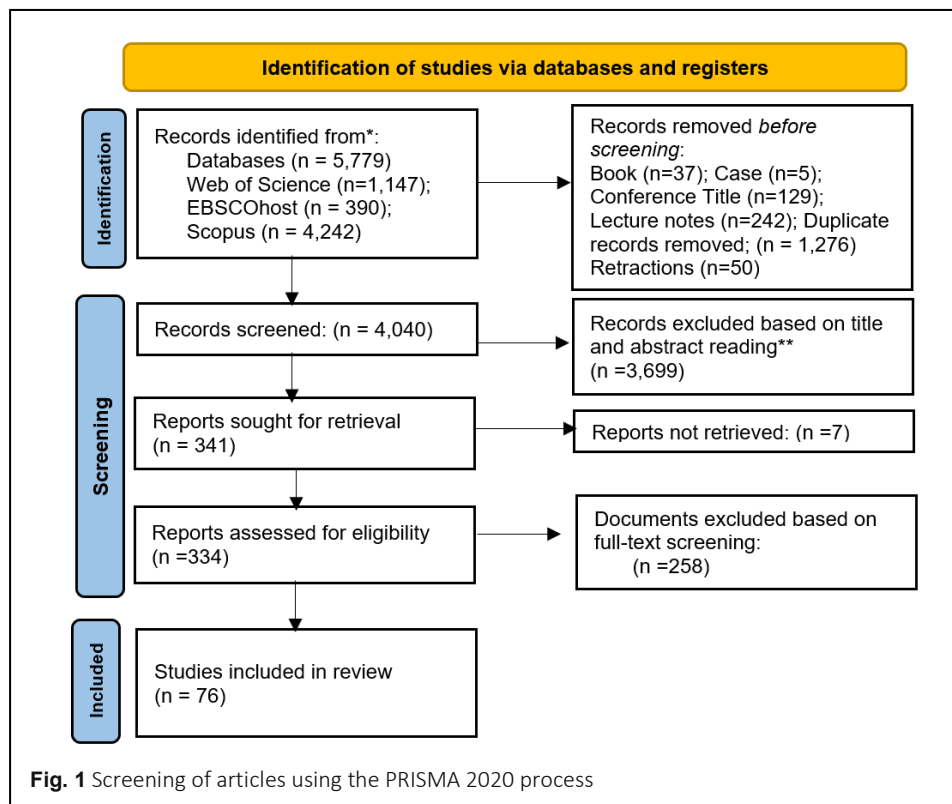
- Studies conducted in HEIs where learning takes place synchronously with at least one student participating in lesson activities onsite in a physical classroom and online via web-conferencing, either individually or as a group;
- Describes teaching staff's experiences or observations of students in an HLE;
 - Studies that described students' perceptions, experiences or learning behaviours in HLE

- Studies that provided data on student learning outcomes in an HLE (e.g., assessment scores, quiz scores, Grade Point Average (GPA), etc.)

Exclusion criteria:

- Studies in K12 education settings
- Studies where content contributes towards professional qualifications, continuing education or requirements in corporate settings
- Studies examining other forms of hybrid curriculum, e.g., hybrid internship

A list of 5,779 articles was extracted and screened from keyword and manual searches before a final list of 76 articles was selected for review. This final list is presented in Figure 1 and is based on the PRISMA 2020 statement (Page et al., 2021). For each of the papers, the nomenclature used to describe hybrid learning, the setting of hybridity, pedagogies used and the research foci were coded. To ensure reliability in the coding result, a second coder reviewed 10% of the papers and Cohen's kappa (κ) was computed. The kappa value $\kappa = 1$ was achieved for nomenclature and settings of hybridity, while the kappa value of $\kappa = 0.84$ and $\kappa = 0.81$ for research foci and pedagogies used within hybrid settings was achieved, respectively. The coders met to discuss the discrepancies and aligned differences. As the kappa value was at least 0.8, there was substantial agreement (Landis & Koch, 1977), and the researcher continued with coding the rest of the papers. The articles and summary of coding are found in the Appendix.



Findings

Descriptive

Studies about hybrid learning (interchangeably known as blended synchronous learning or synchronous hybrid), sometimes referred to as blended learning or HyFlex, grew steadily from 2014 to 2016 as universities started exploring the adoption of different technologies for teaching. Around the same time, the Handbook for Blended Synchronous Learning (Bower et al., 2014) was released in Australia, while the terminology – synchronous hybrid – caught on in 2015 in the United States as researchers adopted the synchronous hybrid learning model of Bell et al. (2015) to teach both in-person and remote students. Research into this phenomenon increased sharply again from 2020 to 2022, where numerous papers discussed the implementation of Hybrid Learning as a result of COVID-19. Descriptive statistics that arose from the analysis are appended in Table 1.

Countries in North America contributed the highest number of papers ($n=26$, 34%) towards the study, where three papers described studies done in Canada (Heilporn & Lakhali, 2021; Lakhali et al., 2020; Lakhali et al., 2021) and in Mexico (Acosta-Gonzaga & Ruiz-Ledesma, 2022; Rodriguez-Paz et al., 2022; Smith et al., 2021) respectively. The remaining papers ($n=20$) focused on studies conducted in the United States of America. Countries in Europe contributed the second highest number of papers ($n=19$, 26%), followed by papers from Asia ($n=16$, 22%). Lastly, four papers (Bower et al., 2015; Egbue et al., 2022; Qiao et al., 2023; Wang et al., 2018) compared students' experiences across multiple countries, and some discussed the implementation of hybrid learning across several campuses and locations during the pandemic (Niksiar et al., 2021; Olt, 2018).

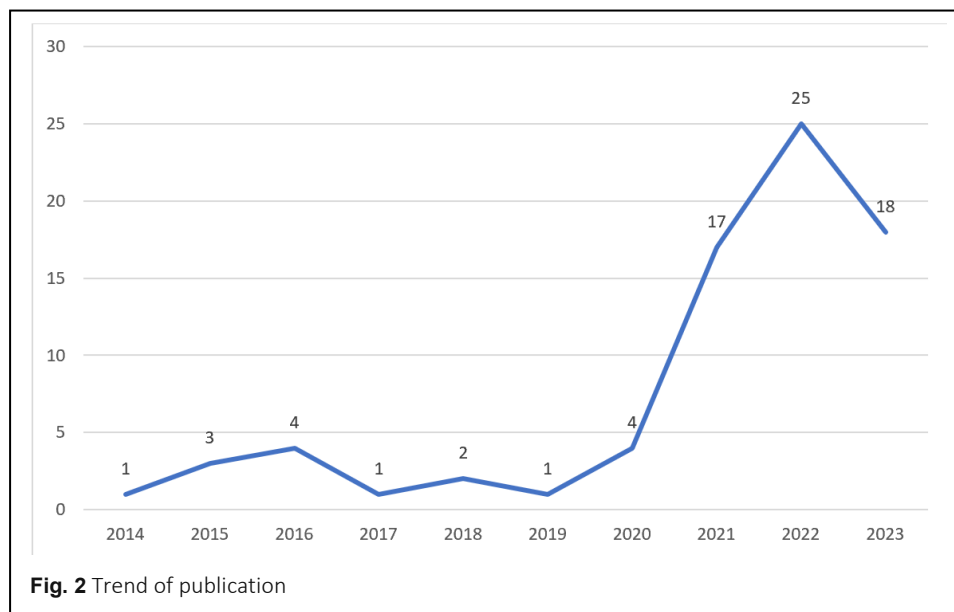


Table 1 Descriptive characteristics of analysed papers

Characteristics	N	% of total articles (N=76)
Site of study		
North America	26	34
Europe	19	25
Asia	16	22
Australasia (Australia and New Zealand)	4	5
South America	2	3
Middle East	4	5
Multiple geographical locations	4	5
Unstated	1	1
Total	76	100
Profile		
Students (n=53)	53	70
Undergraduate	30	40
Postgraduate	8	10
Multiple levels of students	12	16
Unstated year of study	3	4
Teaching Staff	6	8
Multiple Profiles (Staff and Students)	17	22
Total	76	100
Discipline		
Applied Sciences (Computer Science & Engineering)	17	22
Business Management	4	5
Humanities and Social Science	12	16
Medicine & Health Science	3	4
Natural Sciences	10	13
Multiple	30	40
Total	76	100

Seventy percent (n=53) of the papers explored students' experiences, characteristics and outcomes within HLE only, while 22% of the studies reported both students' and staff's experiences learning and lecturing in HLE. Finally, seven papers focused only on staff's experiences and perspectives of delivering learning activities in HLE.

With COVID-19 measures rolled out across universities, a significant number of studies (n=30, 40%) focused on finding out the implementation of hybrid learning across multiple subject areas. These studies were done to discover general sentiments about the rollout of hybrid learning as a whole, regardless of their discipline. 22% of the papers looked into the implementation of hybrid learning in applied sciences (computer science and engineering), followed by 12 and 10 studies which explored how hybrid learning was implemented in humanities and natural sciences, respectively. Lastly, research into business management or medicine and health science were least explored.

Syntheses

The trend of nomenclature across time

The search surfaced a range of terminologies used to describe the dual delivery of synchronous learning activities for in-person and remote students. These terminologies and trends in their use across time were analysed, with the results for using each nomenclature represented in Table 2 and the trend line across the years shown in Figure 3.

Table 2 Nomenclature used to describe hybrid learning

Nomenclature	N	% of total articles (N=76)
Hybrid Learning (HL)	44	58
Synchronous Hybrid (SH)	12	16
Blended Synchronous Learning (BSL)	10	13
HyFlex (HF)	7	9
Blended Learning (BL)	3	4
Total	76	100

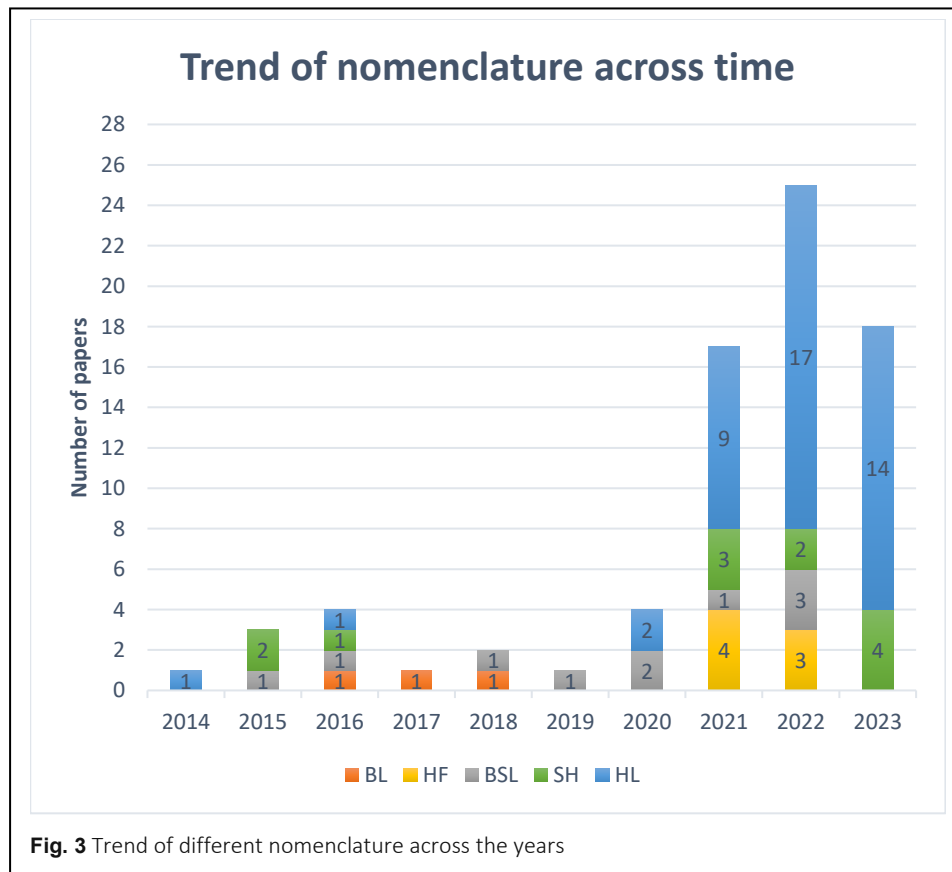


Fig. 3 Trend of different nomenclature across the years

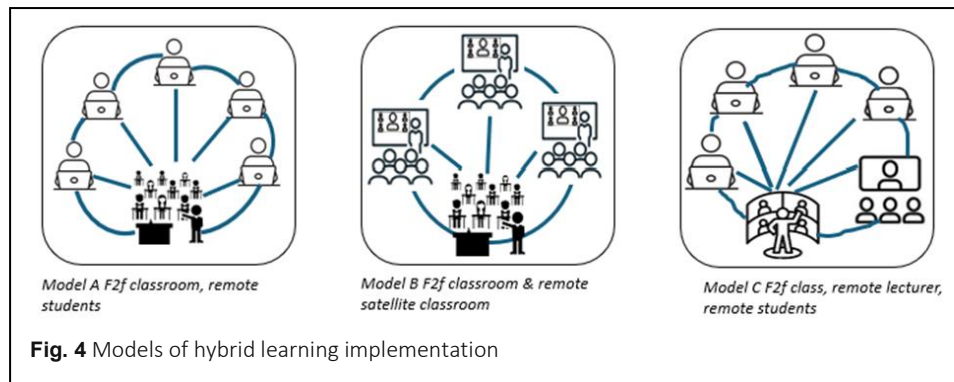
The use of the term blended learning (BL) to describe this phenomenon lasted from 2016 to 2018 (Bower et al., 2017; Lightner & Lightner-Laws, 2016; Olt, 2018). These studies used the word – synchronous – to indicate that learning coincides with a blend of students in different locations within the papers (Olt, 2018). The term – blended synchronous learning (BSL), evolved from BL, was prevalent from 2015 to 2022. Researchers (Bower et al., 2015; Wang et al., 2018) adopted BSL as an umbrella term for instructional methods that simultaneously support teaching and learning for students in physical classrooms and online spaces via computer-mediated communication technologies. In such approaches, on-campus students attend in-person instruction in the physical classroom, and remote students participate in learning activities via two-way, real-time videoconferencing.

First coined by Beatty in 2017, HyFlex, short for a hybrid-flexible model, was prevalent only in 2021 and 2022 in seven papers. The HyFlex model allows students to have the option of participating in learning activities by attending lessons physically in classrooms, synchronously through online web conferencing tools or engage in learning activities asynchronously through recordings and videos (Beatty, 2007). This allowed learners to have complete control of their modality – in-person, online synchronous, or asynchronously online (Irvine, 2020). In addition to managing students in physical and online spaces, teaching staff must ensure that the learning outcomes are met, regardless of where and how students participate. Thus, HyFlex does not include situations where synchronous attendance is required or where no robust asynchronous learning options are provided, as planned learning activities must cater to students who choose to engage with them later (Irvine, 2020).

The adoption of the term Synchronous Hybrid (SH) grew in tandem with Hybrid Learning in recent years from 2021 to 2023. This term clearly illustrates that learning took place simultaneously for students in different spaces. Its adoption started in North America before spreading into Asia (Li et al., 2023; Pham & Tran, 2022), Europe (Giacosa, 2023; Handle-Pfeiffer et al., 2022) and even the Middle East (Usher & Hershkovitz, 2024) in recent years.

Settings of hybridity

Three implementation models of hybridity arose from this review: (i) Model A – Students who were physically present with teaching staff in tutorial rooms or lecture halls while remote students attended classes individually from a site of their choice; (ii) Model B – Students who were physically present with teaching staff while satellite classrooms were set up for groups of students to attend from other locations; and (iii) Model C – A group of students who were physically present in a tutorial rooms or lecture halls with a teaching assistant, remote students attending lectures individually from a site of their choice and teaching staff delivered the session remotely from a different location (see Figure 4).

**Table 3** Settings of hybridity

Types of hybridity	N	% of total articles (N=76)
Model A - f2f Classroom; Onsite teaching staff; Remote student (Individual) (e.g., Alexander et al., 2014)	67	88
Model B - f2f Classroom; Onsite teaching staff; Remote students (satellite classroom with teaching assistant) (e.g., Benitz, 2021)	6	8
Models A or B (Bower et al., 2015)	1	1
Model C - f2f Classroom; Remote teaching staff; Remote student (Individual) (Model C) (e.g., Pavlidou et al., 2021)	12	13
Total	76	100

Table 3 shows the breakdown of the different settings of hybridity were implemented in the studies reviewed. Particularly, Bower et al. (2015) explored the efficacies of both Models A and B through a case study approach.

Most of the studies (n=67, 88%) executed hybrid learning with remote students participating in learning activities through their devices at a location of their choice. Interestingly, six papers described the implementation of hybrid learning by having groups of students participate in learning in smaller groups from different locations. This model of hybridity was helpful for universities with campuses in different locations that had to conduct general education courses for first-year students (Olt, 2018; Smith et al., 2021). Model B also allowed HEIs to adhere to occupancy guidelines during the pandemic when students attended lectures from another lecture hall (Benitz, 2021). Lastly, Pavlidou et al. (2021) described how international lecturers were invited to conduct lectures remotely to some students in a physical classroom during the pandemic, and other students participated virtually.

Teaching staff's design and implementation of learning activities in HLE

As HEIs pivoted to hybrid teaching quickly during the COVID lockdown, teaching staff tried different ways to engage students by adopting different instructional strategies to ensure that all students were meaningfully engaged in the hybrid session (Huizinga et al., 2022). This review sought to find out the pedagogical strategies that teaching staff used in hybrid settings. When attempting to categorise these pedagogical strategies, the authors explored modelling after an existing schema. However, no appropriate models could be readily adopted for HLEs. Being an emerging learning modality, hybrid classrooms require radical shifts in teachers' pedagogical methods (Raes et al., 2020). As authors were interested in strategies that teachers used to foster engagement among students in hybrid spaces, how and whether they executed small group discussions were tabulated.

In some studies, teaching staff rotated students' attendance between in-person and remote lessons attendance, so that all students had the chance to interact with other classmates in person. This enabled students to establish interpersonal relationships in the physical space (Asaad et al., 2022; Sunny & Bucks, 2021). The engagement between students and teaching staff also became more complex as they were exposed to different teaching styles (Asaad et al., 2022). Hence, teaching staff adopted technological tools such as gamification to encourage student interaction across groups (Tan et al., 2022).

Teaching staff encouraged conversations between both groups of students by designing questions for students to participate in smaller groups. In these instances, teaching staff might choose to group students within the same environment ($n=5$) (i.e., groups were formed among students who were all within the physical classrooms or who were all participating remotely) or mix students in different settings to promote social interaction and cohesion ($n=15$). Encouraging students to interact with one another in different locations allowed students who were participating remotely to feel less isolated and such interactions predicted student engagement (Zhong et al., 2022). Correspondingly, students who followed the course through live streaming without interaction with teaching staff or other students had the lowest engagement scores (Raes, 2022). Interactions between groups of students, despite being in different spaces, enabled students to know their peers individually, not just as a face behind the screens. This addressed students' feedback on how social presence could be further enhanced, and allowed them to feel more motivated to participate in deeper learning and supported in the learning process (Huizinga et al., 2022). Conversely, the lack of social presence resulted in lower learning persistence and cognitive engagement (Zhong et al., 2022).

Teaching staff varied their pedagogy depending on the model of hybridity that they adopted. In the study where teaching staff were in a remote location (Model C), the choice of delivery was primarily instructor-led. In this mode of delivery, staff focused on delivering content via lectures and might facilitate extensive group discussions to engage

Table 4 Comparing pedagogies with models of hybridity

Pedagogies within hybrid space	Model	Model	Model	Model	Total
	A	B	A&B	C	
Instructor-led delivery	10	0	0	1	11
Instructor-led delivery with small group discussions across physical spaces (groups are made up of in-person and remote students)	7	1	0	0	8
Instructor-led delivery with small group discussions within the same physical space (groups are made up of in-person and remote students)	3	2	0	0	5
Instructor-led delivery with small group discussions both within and across physical spaces	6	0	1	0	7
Project-based learning	4	1	0	1	6
Unreported	37	2	0	0	39
Total	67	6	1	2	76

learners at different locations. In Benitz's (2021) study, where multiple groups of students are situated in different locations (Model B), the lecturer adopted project-based pedagogy so that students contribute actively to one another's learning. In another instance (Bower et al., 2015), staff created opportunities for students in different locations to interact with one another through group discussions. Similarly, in Model A, 42% (n=13) of all reported pedagogies (n=31) encouraged discussions between students in different locations. Table 4 demonstrates how different pedagogies were adopted for each model.

Research foci of hybrid teaching and learning

An analysis of the research foci of all papers was done and tabulated in Table 5. Understandably, papers focusing on students' perceptions of hybrid learning were the largest (n=22) and they essentially involved the execution of questionnaires and survey forms to determine students' satisfaction levels (Pham & Pham, 2022; Rodriguez-Paz et al., 2021) and their preferences for different delivery methods – face-to-face or online (Kyrkjebø & Stoelen, 2023). Table 5 gives an overview of the different research foci.

Impact of students' dispositions

Researchers were interested in how students' dispositions affected their engagement levels, academic results and satisfaction levels in the hybrid learning space (Raes, 2022; Xiao et al., 2020; Zhong et al., 2022). Twelve papers explored different facets of students' dispositions, such as their morale and motivation levels, self-regulation, perceived control and value and self-efficacy. Instruments such as the Student Engagement and Disaffection in School (SED) (Skinner et al., 2008) and Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & De Groot, 1990) were used to determine the relationship between self-efficacy and learning engagement. Other instruments, such as Perry et al.'s (2001)

Table 5 Foci of research

Research foci	N	% of total articles (N=76)
Students' perspectives only – Students' satisfaction levels, effectiveness, engagement levels (e.g., Alexander et al., 2014)	22	29
Impact of students' dispositions (e.g., Acosta-Gonzaga & Ruiz-Ledesma, 2022)	12	16
Comparative studies across learner groups (e.g., Giacosa, 2023)	5	7
Design and implementation of hybrid teaching and learning (e.g., Lakhali et al., 2020)	11	14
Student outcomes in hybrid spaces – learning engagement, academic scores, attendance (e.g., Lightner & Lightner-Laws., 2016)	7	9
Technological adoption and its efficacy (e.g., Phelps & Moro., 2022)	5	7
Teachers' perspectives only (e.g., Pham & Tran, 2022)	6	8
Both teachers' and students' perceptions (e.g., Al-Enzi et al., 2024)	8	10
Total	76	100

Perceived Academic Control Scale and Pekrun et al.'s (2011) Achievement Emotions Questionnaire (AEQ), were also used to measure students' perceived control and emotions within HLEs.

Researchers also focused on different designs of hybrid spaces and their implementation strategies. Eleven studies explored how different instructional strategies and varied session designs foster students' integration and collaboration within hybrid sessions (Bower et al., 2015; Lakhali et al., 2020). As these studies sought to gain an in-depth understanding of the implementation of hybrid learning, studies were qualitative in nature and involved interviews and focus group discussions (Bower et al., 2015; Pavlidou et al., 2021). The insights into how different designs influenced and impacted students' behaviours in different contexts provided valuable knowledge for practitioners to consider when planning hybrid sessions.

Students' learning outcomes should not be compromised regardless of how learning has been implemented in different modalities. Hence, outcomes in different hybrid spaces and how they compare across different learner groups were investigated in seven of the studies. Students' assessment grades (Butz & Askim-Lovseth, 2015), students' attendance (Verdecchia & Lago, 2023), as well as their engagement levels and interactions within HLEs were evaluated (Szeto & Cheng, 2016). These studies have shown that hybrid learning, as an emerging modality, worked (Lightner & Lightner-Laws, 2016).

Comparative studies between different learner groups and how they might have changed over time were evaluated (Niksiar et al., 2021). These included parameters such as attendance, satisfaction levels, participation data, and students' grades. The studies were primarily done by analysing the results from end-of-semester student feedback forms

(Niksiar et al., 2021; Paiva et al., 2021) and tabulating the number of times different student groups interacted during hybrid sessions (Samson, 2020).

Universities adopted new technological tools such as Kahoot!, SWIVL, etc., when they pivoted to hybrid learning environments quickly during COVID. Four studies explored the efficacy of those technologies and whether students perceived for those tools to be effective in facilitating student interaction (Phelps & Moro, 2022; Rabb et al., 2022). These studies were also done through student feedback at the end of the classes, seeking students' perceived effectiveness of those tools (Rabb et al., 2022) and how they were adopted and used within hybrid settings (Setiawan et al., 2022). Only Zhao's (2023) study adopted qualitative methods to investigate the use of technological platform for hybrid learning, where students' perceptions of the efficacy of each new technological tool were investigated.

Teaching staff's perspectives

Six papers investigated teachers' experiences (Cheng et al., 2023; Handle-Pfeiffer et al., 2022; Li et al., 2023; Pham & Tran, 2022; Romaniuk & Łukasiewicz-Wieleba, 2022; Romero-Hall & Ripine, 2021). The feedback from teaching staff could be classified into three categories: (i) Management and additional efforts in hybrid delivery, (ii) Pedagogical and technological skills, and (iii) Technological and environmental resources.

Management and additional efforts in hybrid delivery

Among the challenges surfaced by teaching staff, the management of the sessions with learners in two different spaces was the most prevalent. With students in two different locations, teaching staff had to respond to not just in-person students but also those participating remotely. Hence, it made it cognitively more challenging for teaching staff as they had to focus on delivering the content, answering questions from in-person students, and monitoring questions from students in the virtual space (Potter & Blundell, 2022). Teaching staff highlighted that the situation worsened when remote students were more passive and chose not to participate actively during hybrid sessions (Giacosa, 2023).

Hybrid teaching demanded a significant increase in the teaching staff's workload as planning and delivering hybrid sessions was similar to delivering in two different spaces. Teaching staff must redesign materials to ensure they fit hybrid teaching (Lakhali et al., 2021) and have appropriate technical arrangements that fit remote and in-person students. This was made more difficult in practice-based sessions where different in-class activities were needed for the different groups of students (Li et al., 2023).

Lastly, papers also surfaced the ratio of remote students to in-person students in which teaching staff feel comfortable in managing HLEs. Lakhali et al. (2021) highlighted that a ratio of a third of the students being online but not more than half is manageable. A tutorial

session of 30 students equates to staff managing 10 students online and another 20 students in a physical space. Maintaining a reasonable ratio of the number of in-person students to those online may be necessary for teaching staff to manage and support hybrid learning effectively (Bower et al., 2015).

Pedagogical and technological skills

Teaching staff need the technological skills to select the most optimal platform for their discipline and manage students interacting within the electronic platforms from two locations (Krishnan & Nagaratnam, 2023; Pramila-Savukoski et al., 2023). Proficiency in technological platforms would enable teaching staff to facilitate student interaction and integration from both locations (Lakhal et al., 2020).

The lack of proper training for hybrid teaching methods and top-down support systems to upskill teaching staff in online tools resulted in them feeling less confident and prepared as they transitioned into hybrid instruction (Romero-Hall & Ripine, 2021). Hence, additional support, such as providing more support on hybrid course development and access to experienced staff who have delivered hybrid instruction, could boost staff's confidence in hybrid teaching (Cheng et al., 2023). Overall, the teaching staff's competency in managing technological platforms directly impacted their confidence in navigating unforeseen situations (Zhao, 2023).

Technological and environmental resources

Teaching staff reported internet connectivity as an issue when delivering lessons, especially for off-campus students (Giacosa, 2023). Internet connectivity was often intermittent, causing trouble for remote students to stay connected during lessons. They would then have to spend time resolving such technology issues, disrupting the lessons' flow (Pham & Tran, 2022). Students within the physical classroom would also be left stranded and not meaningfully engaged as staff attempted to fix these technological issues (Pham & Tran, 2022). Teaching staff also highlighted access to software and applications as a way to promote student engagement during the sessions. The availability and ease of access to various external applications, such as Padlet (<https://padlet.com/>) and Mentimeter (<https://www.mentimeter.com/>), allowed students in different environments to interact and collaborate (Pham & Tran, 2022). Separately, teaching staff used applications such as Kahoot! (<https://kahoot.com/>) and the polling function within Zoom (<https://www.zoom.com/>) as a formative assessment tool to assess students' learning. This was especially important when teaching staff were unable to assess remote students' nonverbal cues to ascertain whether they understood the class (Bower et al., 2015; Li et al., 2024; Phelps & Moro, 2022).

In addition to technological constraints, environmental factors also contributed to teaching staff's experiences within HLEs. A critical factor that determined the success of a hybrid session was the availability of sufficient audio equipment, particularly microphones, that could capture voices from around the classrooms (Verdecchia & Lago, 2023). Ideally, the provision of drop mics around lecture halls or classrooms would enable the capturing of group discussions at each group (Alexander et al., 2014; Marey et al., 2022; Raes, 2022), which would facilitate the participation of remote students with onsite students.

Discussion

Current conception of hybrid learning

This systematic review revealed how scholars understood terminologies and definitions differently. As seen in Table 2, while different nomenclatures were adopted, all papers were describing the same phenomenon of synchronous learning for different student groups, with at least one student participating from a physical location or virtually. In each instance, at least one teaching staff member, demonstrator, or teacher-aide was co-located with students in the physical classroom. In Pavlidou et al.'s (2021) study, international lecturers taught from remote locations as the pandemic has rendered them unable to lecture in a physical classroom. The use of different nomenclature to describe the same phenomenon has evolved from being referred to as blended learning during pre-pandemic years (Bower et al., 2017; Lightner & Lightner-Laws, 2016; Olt, 2018) to the proliferation of Hybrid Learning and Synchronous Hybrid Learning in recent years. Graham's (2006) definition of blended learning, which refers to the combination of face-to-face instruction with computer-mediated instruction as a curriculum design, has been readily adopted. While hybrid learning is referred to as the modality where students could learn synchronously with their peers from a location of their choice. Students were given the freedom and flexibility to choose where they wanted to undergo their learning (Krishnan & Nagaratnam, 2023). Therefore, the term – hybrid learning – is most commonly used to describe the same phenomenon of conducting lessons with a group of students being onsite and others participating in the same lesson remotely through web-conferencing tools (Asaad et al., 2022; Marey et al., 2022; Morris et al., 2021; Paiva et al., 2021). To make clear the concurrent delivery of lessons to different groups of students, the term synchronous has been added to Blended Learning or Hybrid Learning. Ten papers and 12 referred to this emerging modality as Blended Synchronous Learning (BSL) or Synchronous Hybrid Learning, respectively. This way of delivering courses allowed students in different campuses to interact with one another and was used to deliver courses that were generic to the student population (Olt, 2018; Smith et al., 2021).

Teaching staff's design of hybrid learning spaces

In many cases, a key consideration of teaching staff when designing and delivering in hybrid settings involved deciding features that fostered collaboration and integration of students in different spaces (Bower et al., 2015; Lakhali et al., 2020). Varying and adopting different design methods allowed teaching staff to ascertain how adopting different technologies and teaching formats encouraged interaction and cooperation between different learner groups (Bower et al., 2017; Raes, 2022). Being aware of the number of in-person and remote students for each class allowed the teaching staff to design lesson activities better. Having prior sight of the number of students in each setting helped in the appropriate deployment of learning activities that cater to both learner groups (Lakhali et al., 2021).

In addition, teaching staff considered the availability of various technological tools and environmental resources. This includes being in a location with a strong broadband connection that supports delivering all applications and software they might use during lessons (Butz et al., 2015). Understanding how different factors affect the emotional tone of technology-enriched learning environments and how it differs from traditional, on-campus delivery is critical when examining programme achievement and technology use (Butz et al., 2015). Teaching staff's confidence and proficiency in their choice of technology tools aid in delivering the lessons considerably, thus impacting students' overall experience in HLE. Being familiar with the different applications that they might likely use during the lesson and choosing applications which were readily accessible to students ensured that the lessons flowed smoothly (Pham & Tran, 2022; Romero-Hall & Ripine, 2021).

A physical environment suited for hybrid learning is critical in fostering social engagement between in-person and remote students. The availability of microphones or strategically located microphones allowed discussions to be captured within lectures or tutorials (Bower et al., 2015; Bower et al., 2017; Rabb et al., 2022). This allowed remote students to listen in to discussions within the classroom and contribute actively to them. Thus, knowing the environment and situation that they would be in, then planning and redesigning hybrid sessions were vital to ensuring that lessons ran smoothly (Wang et al., 2018) while remaining interactive to all learners (Lakhali et al., 2021).

Across papers, the issue of engagement has always been of concern between students and teachers. In-person students would have an advantage over remote students as their physical proximity allowed teaching staff to assess their learning through non-verbal cues such as eye contact, hand and arm motions, facial expressions, voice fluctuations and movement (York, 2015). There is no doubt that remote students benefited less from non-verbal immediacy with their lecturers and peers. However, some studies have mediated this by increasing digital proximity through backchannels (Hayes & Tucker,

2021). A backchannel is an informal digital platform for communication in a cohort (Hayes & Tucker, 2021; Pohl et al., 2011) and allows remote and f2f students to interact across attendance modes (Butz et al., 2015). Teaching staff who found it hard to manage remote and f2f students simultaneously turned to teaching assistants and other technological tools to manage various problems (Cheng et al., 2023; Lakhali et al., 2021). While lessons were ongoing, teaching assistants would monitor the chat interface to address any queries that remote students might post, regardless of whether they pertain to the lesson or any technological issues (Li et al., 2023). Notably, most web-conferencing tools today would already have been embedded with a backwards chat interface, e.g., Adobe Connect, Cisco WebEx, Zoom, etc. Li et al. (2024) found that online students wanted to be active participants in the lesson and wanted to interact and collaborate with others within the class. Thus, having backchannel communication that allows remote students to raise questions via chat or “reactions” is a means to maintain two-way communication between remote and physical settings.

To further encourage interaction between in-person and online students, some teaching staff adopted a partnership strategy where in-person students helped to monitor the chat functions and notify instructors promptly of any issues faced by remote students (Wang et al., 2018). While the partnership model might work well to foster engagement between students in the two groups, classroom partners might be easily distracted due to the need to constantly monitor in-class chats, which in turn, affect their engagement within the class (Stewart et al., 2011; Wang et al., 2018). Hence, caution must be taken to limit the mode of monitoring (i.e., monitoring either the audio or chat function) or to use the help of a teaching assistant instead.

Backchannel communication might not be limited to chat communication platforms during lessons but could include other platforms such as Facebook, WeChat, Telegram, etc. Smaller chat groups created for projects allow active learning and act as conduits for students to clarify doubts and initiate discussions with teaching staff outside of class time (Tan et al., 2022). Furthermore, these social platforms help strengthen connections and encourage interaction between learners outside class time (Uukkivi et al., 2022). These spaces play an essential role for geographically dispersed students and allow them to feel more socially connected, and do not cause difficulties in collaborating online with other learners (Uukkivi et al., 2022). Thus, backchannel communication could be adopted to reduce inequities among students in physical and remote spaces (Hayes & Tucker, 2021).

Students’ learning behaviours in HLE

Equally important is students’ involvement in the hybrid learning process. Compared to an in-person setting, students might be used to being “spoon-fed” and having content presented to them (Pham & Pham, 2022); students are expected to be active and engaged

in the search for content in HLE, especially since teachers are constantly splitting their attention between f2f and remote students (Pham & Tran, 2022). Hence, students' attributes, motivations, self-regulation, and self-efficacy contribute to their levels of engagement, learning persistence and achievement during learning (Sinatra et al., 2015; Zhong et al., 2022). This is supported by Qiao et al. (2023), who found that intrapersonal indicators such as self-regulation, learning ability and information literacy directly impact learners' learning outcomes. Butz et al. (2015) found that students' self-efficacy has a positive relationship with their academic engagement as it influences their degree of engagement and effort invested in the learning activity. Especially for students participating in the lessons remotely, a critical success factor would be their intrinsic motivation to want to do well during the lesson (Bower et al., 2017). This is supported by Van der Rijst et al. (2023), whose study found that students engage and interact more in hybrid sessions when they feel they are enjoying it and can participate easily during classes. Hence, teaching staff must redesign activities to make student-student interactions workable for both remote and in-person students (Van der Rijst et al., 2023).

Other feedback from students includes surfacing that they are more distracted during lessons, especially those attending classes online (Asaad et al., 2022). This includes being distracted by noise from other participants' backgrounds (Wang et al., 2018) or by other available gadgets or online scrolling (Pavlidou et al., 2021). Similarly, in-person students can be distracted by remote students, especially if teaching staff spend a significant amount of time resolving technological issues (Pham & Pham, 2022) or if they have been tasked to partner with remote students and facilitate interaction which caused them to be distracted themselves (Wang et al., 2018).

Student interaction patterns were tracked in some studies (Szeto & Cheng, 2016; Verdecchia & Lago, 2023). Researchers found that while there were fewer inter and intra interactions across and between remote and in-person students, remote students interact with teaching staff more often than in-person students (Szeto & Cheng, 2016). Studies also found that cognitive and social-emotional interactions were most observed in hybrid settings, which helped to facilitate collaborative learning across different learner groups (Pramila-Savukoski et al., 2023).

Learning achievement is related to learning engagement (Zhong et al., 2022) which is affected by motivations (Wang & Eccles, 2013) and motivation is known to be related to self-determination (Deci & Ryan, 2012). Hence, understanding students' motivation might shed light on understanding how students behave in HLE. However, the link between students' attributes and engagement between students in hybrid learning remains to be explored further (Phelps & Moro, 2022).

Students' perceptions and outcomes in different settings of hybridity

Of the three models being discussed, students perceived their social engagement experience as unfavourable in the Model C setting. Students found posts on discussion forums to lack quality, as students often posted for the sake of having marks (Pavlidou et al., 2021). Having teaching staff in remote locations might not facilitate social interactions optimally. Hence, students found it hard to establish deep connections (Pavlidou et al., 2021). Studies where satellite classrooms were conducted (Model B) reported a positive social experience among students. Perhaps this was due to the higher level of interaction density within each group within the physical space and students in the remote setting (Szeto & Cheng, 2016). In Benitz's (2021) study, adopting a project-based learning approach allowed students in different spaces to communicate actively with one another. Students were put in the role of an "instructor" and were tasked to "teach" their classmates course content. Gathering information, creating materials and delivering the presentation allowed the students to feel more engaged with one another in such settings (Benitz, 2021). Human factors also play a massive role in improving social presence between groups of students (Bower et al., 2015). As there is a lack of f2f interactions with other students on remote campuses, the insertion of humour and the use of collaborative technologies would improve the sense of co-presence in students (Bower et al., 2015). Hence, there remains potential to research into how the sense of community between remote and f2f students can be increased (Lidstone & Shield, 2010; Shield et al., 2005).

Studies have shown that hybrid learning did not significantly lower students' grades. Only one study Irani-Kermani et al. (2021) reported a decrease in students' grades, while others reported that students either maintained their grades or showed improvement, e.g., Smith et al. (2021). This showed that while the level of engagement may not be as high in hybrid settings, students were finding ways to maintain their grades even though the pandemic might have affected their learning experiences (Verdecchia & Lago, 2023).

Separately, students highlighted the importance of having a stable internet connection to remain connected during lessons and catch up with discussions (Asaad et al., 2022; Lakhali et al., 2021; Pham & Pham, 2022). As teachers adopt other technological platforms to promote students' engagement, students must be in an environment with constant internet connectivity to actively participate in learning activities. In papers that reported positive learning engagement, teaching staff reported having a smooth internet connection or access to appropriate technological applications suited for their classes (Alwadood et al., 2023; Phelps & Moro, 2022). On the other hand, technological issues might cause a loss of information or a reduction in the sense of virtual co-presence (Bower et al., 2015). Failure to ensure smooth connectivity would cause remote students to feel excluded from the class as they were already physically separated from f2f classes, especially if they could not resolve technological issues fast enough (Huang et al., 2017). Students reported negative

emotions with technology-related issues, such as being unable to participate actively in live quizzes or dropping in and out of synchronous learning sessions (Butz et al., 2015; Pham & Pham, 2022). Intermittent internet connectivity disrupts students' learning and creates additional stress as they have to fix technological issues while, at the same time, staying connected with the lesson (Acosta-Gonzaga & Ruiz-Ledesma, 2022).

Lastly, of all the studies that reflected students' positive experiences within the HLE, teaching staff were also comfortable with the ratio of in-person and remote studies within the hybrid sessions. This highlights that teachers being comfortable with the number of in-person and remote students translates to how they deliver the sessions, affecting students' overall experience within HLEs.

Limitations and further research

A fundamental limitation of this study is the fast-evolving nature of this field; hence, it would not be able to comprehensively capture new studies done in this field with hybrid learning being an emerging modality. In addition, this literature review is limited to the papers that are found based on the search terms used and are limited to papers published in English within the time period from the identified databases. As different nomenclatures had been used to describe this modality, other researchers might have used other ways to describe hybrid learning, which were not captured within the search terms.

While hybrid learning might be a stop-gap measure for some universities, this form of delivery remains relevant as it brings together students from different locations. Furthermore, students see the flexibility that hybrid learning offers and have acquired online learning competencies to learn in such environments. They would thus more likely opt to attend lessons in a hybrid setting, especially if teaching staff allowed students to interact with their peers in person at least once during the semester.

As identified by other studies (Li et al., 2024; Raes et al., 2019) within the field, pedagogical aspects of hybrid learning remain a research gap. Li et al. (2024) highlighted that most studies focused on pedagogical perspectives from teachers' points of view, and few addressed students' perceptions of hybrid learning. In our current review, while the majority of the studies (n=43) were centred around students' experiences and outcomes within Hybrid Learning, few (Ørngreen et al., 2015; Rabb et al., 2022; Zhong et al., 2022) studied the affective domain of students' behaviours. While studies looked at students' outcomes and levels of engagement within the environment, students' attributes and how they affect learning remain a research gap (Li et al., 2021). The impact of personal dispositions on learning outcomes necessitates a more profound examination, intending to create personalised learning paths tailored to individual needs within the hybrid model. Hence, further research could be done on how students' self-efficacy, motivation and self-regulation levels affect their engagement and student behaviours.

Moreover, ensuring equity and access in hybrid learning is paramount, necessitating an investigation into the disparities in technology access and devising strategies to offer equal learning opportunities for all students. Finally, the efficacy of various support systems for teachers and students, alongside the critical role of administrative support, must be explored to ensure the successful implementation and sustainability of hybrid learning models.

Conclusion

The higher education sector is undergoing a profound transformation with the rise of HLEs, which blend in-person and remote teaching to cater to diverse learning needs. Across papers, while students were generally satisfied with hybrid learning and some studies found students' grades to be not affected by their mode of attendance (Butz & Askim-Lovseth, 2015; La Rosa & Mavroudi, 2022), the inability to interact in f2f settings affected students' overall satisfaction levels. From the teaching staff's perspectives, managing students in different spaces well is one of their main concerns (Lakhal et al., 2021).

In addition, while this review highlighted different aspects of hybrid teaching and learning being studied, these studies were limited to questionnaires and surveys issued to students at the end of the semester. Hence, a gap remains in determining how the design of these environments should be to ensure equality and support for both remote and onsite students.

Students' learning profiles have changed and might be more used to self-regulation processes (Moura et al., 2023). Hybrid learning has the potential to deliver a dynamic and stimulating learning environment that could support diverse learning needs with the adoption of flexible pedagogies (Bashir et al., 2021). It also could combine the benefits of in-person learning as it can provide a sense of social interaction between peers while still providing the flexibility of online learning for students in tertiary HEIs (Lakhal et al., 2021; Wang et al., 2018).

However, the interplay between physical and virtual spaces and how students in both environments respond to one another within and across spaces remains a research gap. While this review highlighted students' perceptions and emotions of their experiences within HLE, underpinning attributes and how they might contribute to their behaviour and experiences could be further uncovered (Li et al., 2024).

Given the number of papers published regarding Hybrid Learning since 2020, it is evident that hybrid teaching and learning is an emerging learning modality due to the pandemic. However, different dimensions of hybrid teaching still require further research to understand its affordances and efficacies. Similar to how online learning will become more prevalent in this current age and time, hybrid learning will continue to bring different students from different locations into the same environment for learning (Egbue et al.,

2022). This review has shown that while students are more comfortable with learning online, in-person engagement cannot be replaced entirely by virtual modes, and students favour hybrid teaching and learning to fully f2f or full online (Egbue et al., 2022; Verdecchia & Lago, 2023). Understanding student engagement and interaction in these environments is critical, calling for longitudinal research and analysis of peer dynamics.

Appendix: Selected articles and coding table

Table A1 Coding table

SN	Author and article information	Nomenclature	Settings of hybridity	Pedagogical strategies	Research foci
1	Acosta-Gonzaga & Ruiz-Ledesma (2022) Site: North America Profile: Students – Undergrad Discipline: Natural Sciences	HL	A	NR	F4
2	Al-Enzi et al. (2024) Site: Middle East Profile: Staff and Students Discipline: Multiple	HL	A	NR	F3
3	Alexander et al. (2014) Site: North America Profile: Students – Multiple levels Discipline: Multiple	HL	A	NR	F3
4	Alwadood et al. (2023) Site: Asia Profile: Students – Multiple levels Discipline: Natural Sciences	HL	A	NR	F3
5	Asaad et al. (2022) Site: Middle East Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	T	F6
6	Atmojo et al. (2021) Site: Europe Profile: Students – Multiple levels Discipline: Applied Sciences (Computer Science & Engineering)	HL	C	TC	F3
7	Benitz (2021) Site: North America Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HL	B	PBL	F3
8	Bower et al. (2015) Site: Multiple Profile: Staff and Students Discipline: Multiple	BSL	A, B	TC	F2
9	Bower et al. (2017) Site: Australasia Profile: Students – Undergrad Discipline: Humanities and Social Science	BL	A	TC	F2

SN	Author and article information	Nomenclature	Settings of hybridity	Pedagogical strategies	Research foci
10	Brown & Tenbergen (2021) Site: North America Profile: Staff and Students Discipline: Natural Sciences	HF	A	TC	F2
11	Butz & Askim-Lovseth (2015) Site: North America Profile: Student – Postgrad Discipline: Business Management	SH	A	NR	F5
12	Butz et al. (2015) Site: North America Profile: Student – Postgrad Discipline: Multiple	SH	A	NR	F3
13	Butz et al. (2016) Site: North America Profile: Student – Postgrad Discipline: Multiple	SH	A	NR	F4
14	Cheng et al. (2023) Site: North America Profile: Student – Teaching Staff Discipline: Multiple	SH	A	TA	F3
15	Corzo-Zavalet et al. (2023) Site: South America Profile: Student – Undergrad Discipline: Multiple	HL	A	NR	F3
16	Egbue et al. (2022) Site: Multiple Profile: Student – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	NR	F3
17	Fabula (2022) Site: Asia Profile: Student – Undergrad Discipline: Multiple	HL	A	NR	F3
18	Giacosa (2023) Site: Europe Profile: Staff and Students Discipline: Humanities and Social Science	SH	A	TA	F1
19	Hamlin et al. (2021) Site: North America Profile: Student – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	SH	A	TA	F3
20	Handle-Pfeiffer et al. (2022) Site: Europe Profile: Teaching Staff Discipline: Multiple	SH	A	T	F3
21	Hayes & Tucker (2021) Site: Australasia Profile: Staff & Students Discipline: Humanities and Social Science	HL	A	TA	F3

SN	Author and article information	Nomenclature	Settings of hybridity	Pedagogical strategies	Research foci
22	He et al. (2020) Site: North America Profile: Student – Unknown levels Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	NR	F3
23	Head (2016) Site: Australasia Profile: Student – Multiple Discipline: Multiple	HL	A	NR	F4
24	Heilporn & Lakhali (2021) Site: North America Profile: Student – Postgrad Discipline: Business Management	HF	A	T	F3
25	Hu et al. (2022) Site: Asia Profile: Student – Undergrad Discipline: Natural Sciences	HL	A	NR	F4
26	Huizinga et al. (2022) Site: Europe Profile: Staff & Students Discipline: Multiple	HL	A	TB	F3
27	Irani-Kermani et al. (2021) Site: North America Profile: Student – Undergrad Discipline: Natural Sciences	HL	A	NR	F3
28	Krishnan & Nagaratnam (2023) Site: Asia Profile: Staff & Students Discipline: Multiple	HL	A	NR	F3
29	Kyrkjebø & Stoelen (2023) Site: Europe Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HL	B	TA	F3
30	La Rosa & Mavroudi (2022) Site: Europe Profile: Students – Undergrad Discipline: Natural Sciences	HL	A	TB	F1
31	Lakhali et al. (2020) Site: North America Profile: Staff & Students Discipline: Humanities and Social Science	BSL	A	PBL	F2
32	Lakhali et al. (2021) Site: North America Profile: Staff & Students Discipline: Humanities and Social Science	BSL	A	NR	F3
33	Li et al. (2023) Site: Asia Profile: Teaching Staff Discipline: Multiple	HL	A	NR	F3
34	Li et al. (2023) Site: Asia Profile: Students – Multiple levels Discipline: Multiple	SH	A	NR	F3

SN	Author and article information	Nomenclature	Settings of hybridity	Pedagogical strategies	Research foci
35	Li & Bringardner (2021) Site: North America Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	PBL	F4
36	Li et al. (2024) Site: Asia Profile: Staff & Students Discipline: Multiple	BSL	A	TA	F3
37	Lightner & Lightner-Laws (2016) Site: North America Profile: Students – Unknown levels Discipline: Business Management	BL	B	NR	F5
38	Linville & Wallen (2022) Site: Unknown Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HF	A	T	F5
39	Lorenzo-Lledó et al. (2021) Site: Europe Profile: Students – Undergrad Discipline: Humanities and Social Science	HL	A	NR	F3
40	Marchisio et al. (2022) Site: Europe Profile: Students – Undergrad Discipline: Multiple	HL	A	NR	F2
41	Martín-del-Pozo & Martín-Sánchez (2022) Site: Europe Profile: Students – Undergrad Discipline: Humanities and Social Science	HL	A	NR	F4
42	Niksiar et al. (2021) Site: North America Profile: Students – Multiple levels Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	NR	F1
43	Öberg et al. (2019) Site: Europe Profile: Staff and Students Discipline: Applied Sciences (Computer Science & Engineering)	BSL	A	PBL	F3
44	Olt (2018) Site: North America Profile: Students – Undergrad Discipline: Humanities and Social Science	BL	B	TB	F3
45	Paiva et al. (2021) Site: South America Profile: Students – Undergrad Discipline: Medicine & Health Science	SH	A	T	F1

SN	Author and article information	Nomenclature	Settings of hybridity	Pedagogical strategies	Research foci
46	Pavlidou et al. (2021) Site: Asia Profile: Students – Postgrad Discipline: Business Management	HL	C	T	F2
47	Pham & Pham (2022) Site: Asia Profile: Students – Multiple levels Discipline: Multiple	HL	A	NR	F3
48	Pham & Pham (2022) Site: Asia Profile: Teaching Staff Discipline: Multiple	SH	A	TA	F3
49	Phelps & Moro (2022) Site: Australasia Profile: Students – Undergrad Discipline: Medicine & Health Science	HL	A	T	F6
50	Potter & Blundell (2022) Site: Europe Profile: Staff & Student Discipline: Natural Sciences	BSL	A	T	F2
51	Pramila-Savukoski et al. (2023) Site: Europe Profile: Students – Undergrad Discipline: Medicine & Health Science	HL	A	TC	F4
52	Qiao et al. (2023) Site: Multiple Profile: Students – Multiple levels Discipline: Multiple	HL	A	NR	F4
53	Rabb et al. (2022) Site: North America Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HF	A	NR	F6
54	Raes (2022) Site: North America Profile: Staff & Students Discipline: Multiple	HL	A	PBL	F4
55	Richard & Moore (2022) Site: North America Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HF	A	T	F5
56	Rodriguez-Paz et al. (2022) Site: North America Profile: Students – Multiple levels Discipline: Natural Sciences	HL	A	NR	F3
57	Romaniuk & Łukasiewicz-Wieleb (2022) Site: Europe Profile: Teaching Staff Discipline: Multiple	HL	A	NR	F3

SN	Author and article information	Nomenclature	Settings of hybridity	Pedagogical strategies	Research foci
58	Romero-Hall & Ripine (2021) Site: North America Profile: Teaching Staff Discipline: Multiple	HL	A	TC	F3
59	Samson (2020) Site: North America Profile: Students – Undergrad Discipline: Natural Sciences	BSL	A	NR	F1
60	Sanchez et al. (2022) Site: North America Profile: Students – Multiple levels Discipline: Natural Sciences	HF	A	TA	F3
61	Setiawan et al. (2022) Site: Asia Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	NR	F6
62	Smith et al. (2021) Site: North America Profile: Students – Undergrad Discipline: Humanities and Social Science	HL	B	TB	F2
63	Sunny & Bucks (2021) Site: North America Profile: Staff & Students Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	TB	F5
64	Szeto & Cheng (2016) Site: Asia Profile: Students – Undergrad Discipline: Applied Sciences (Computer Science & Engineering)	BSL	B	NR	F5
65	Tan et al. (2022) Site: Asia Profile: Students – Multiple levels Discipline: Multiple	HL	A	TC	F2
66	Tan et al. (2024) Site: Asia Profile: Students – Undergrad Discipline: Multiple	HL	A	NR	F3
67	Trotter & Qureshi (2023) Site: Middle East Profile: Students – Undergrad Discipline: Multiple	HL	A	NR	F3
68	Usher & Hershkovitz (2024) Site: Middle East Profile: Staff & Students Discipline: Multiple	SH	A	NR	F3
69	Uukkivi et al. (2022) Site: Europe Profile: Students – Undergrad Discipline: Multiple	HL	A	NR	F2
70	Van der Rijst et al. (2023) Site: Europe Profile: Staff & Students Discipline: Multiple	HL	A	T	F4

SN	Author and article information	Nomenclature	Settings of hybridity	Pedagogical strategies	Research foci
71	Verdecchia & Lago (2023) Site: Europe Profile: Students – Postgrad Discipline: Applied Sciences (Computer Science & Engineering)	HL	A	NR	F5
72	Wang et al. (2018) Site: Multiple Profile: Students – Postgrad Discipline: Humanities and Social Science	BSL	A	TC	F3
73	Wheele et al. (2023) Site: Europe Profile: Students - Postgrad Discipline: Humanities and Social Science	HL	A	NR	F2
74	Xiao et al. (2020) Site: Asia Profile: Students – Unknown levels Discipline: Multiple	HL	A	NR	F4
75	Zhao (2023) Site: Europe Profile: Staff & Students Discipline: Multiple	HL	A	NR	F6
76	Zhong et al. (2022) Site: Asia Profile: Students – Multiple levels Discipline: Humanities and Social Science	BSL	A	T	F4

Table A2 Legend of Coding table

Nomenclature	
HL	Hybrid Learning
BSL	Blended Synchronous Learning
SH	Synchronous Hybrid
BL	Blended Learning
HF	HyFlex
Settings of hybridity	
A	f2f students and remote students
B	f2f students and satellite classroom
C	f2f students, remote students and remote teachers
Pedagogical strategies	
T	Teacher-led delivery
TA	Teacher-led delivery with small group discussions across physical spaces
TB	Teacher-led delivery with small group discussions within the same physical space
TC	Teacher-led delivery with small group discussions both within and across physical spaces
PBL	Project-based learning
NR	Unreported
Research foci	
F1	Comparative studies
F2	Design and implementation of hybrid teaching and learning
F3	Perception studies
F4	Impact of students' dispositions
F5	Outcomes in hybrid spaces
F6	Technological adoption and efficacy

Abbreviations

AEQ: Achievement Emotions Questionnaire; BL: Blended Learning; BSL: Blended Synchronous Learning; f2f: Face-to-face; GPA: Grade Point Average; HEI: Higher Education Institution; HF: HyFlex; HL: Hybrid Learning; HLE: Hybrid Learning Environment; MSLQ: Motivated Strategies for Learning Questionnaire; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SED: Student Engagement and Disaffection in School; SH: Synchronous Hybrid; STA: Systematic and Tripartite Approach.

Authors' contributions

PJS: Conceptualisation; Methodology; Formal analysis; Investigation; Resources; Data curation; Writing – Original draft; Writing – Review & editing; Visualisation. BD: Conceptualisation; Validation; Supervision; Writing- Review & editing. JK: Conceptualisation; Validation; Supervision; Writing- Review & editing.

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References

- Acosta-Gonzaga, E., & Ruiz-Ledesma, E. F. (2022). Students' emotions and engagement in the emerging hybrid learning environment during the COVID-19 pandemic. *Sustainability*, *14*(16). <https://doi.org/10.3390/su141610236>
- Akkoyunlu, B., & Soylu, M. Y. (2006). A study on students' views on blended learning environment. *Turkish Online Journal of Distance Education*, *7*(3), 43–56.
- Al-Enzi, A., Almutawaa, D. S., Al-Enezi, D., & Allougman, F. (2024). An analysis of the academic effectiveness of hybrid learning: The experiences of faculty and students in Kuwait. *Journal of Applied Research in Higher Education*, *16*(2), 328–342. <https://doi.org/10.1108/JARHE-09-2022-0283>
- Alexander, M. M., Lynch, J. E., Rabinovich, T., & Knutel, P. G. (2014). Snapshot of a hybrid learning environment. *Quarterly Review of Distance Education*, *15*(1), 9–21.
- Alwadood, Z., Halim, S. A., Bakar, S. A., & Noor, N. M. (2023). Assessing student perceptions on hybrid learning. *International Journal of Evaluation and Research in Education*, *12*(3), 1582–1590. <https://doi.org/10.11591/ijere.v12i3.25126>
- Asaad, S., Salti, H., & Farhat, M. (2022). Engineering students' engagement in a hybrid learning mode: Comparative study. In M. S. Gudjonsdottir, H. Audunsson, A. M. Donoso, G. Kristjansson, I. Saemundsdóttir, J. T. Foley, M. Kyas, A. Sripakagorn, J. Roslöf, J. Bennedsen, K. Edström, N. Kuptasthien & R. Lyng (Eds.), *Proceedings of the 18th International CDIO Conference* (pp. 465–473). Reykjavík University.

- Atmojo, U. D., Azangoo, M., Vyatkin, V., & Seilonen, I. (2021). From face to face to hybrid teaching: An experience on process plant automation laboratory course during global pandemic. In *2021 IEEE 19th International Conference on Industrial Informatics* (pp. 1–6). IEEE. <https://doi.org/10.1109/INDIN45523.2021.9557440>
- Bashir, A., Bashir, S., Rana, K., Lambert, P., & Vernallis, A. (2021). Post-COVID-19 adaptations; the shifts towards online learning, hybrid course delivery and the implications for biosciences courses in the higher education setting. *Frontiers in Education*, 6, 711619. <https://doi.org/10.3389/educ.2021.711619>
- Beatty, B. J. (2007, October). *Hybrid classes with flexible participation options – If you build it, how will they come?* Paper presented at the 2007 Association for Educational Communications and Technology Annual Convention. Association for Educational Communications and Technology.
- Bell, J., Sawaya, S., & Cain, W. (2014). Synchromodal classes: Designing for shared learning experiences between face-to-face and online students. *International Journal of Designs for Learning*, 5(1). <https://doi.org/10.14434/ijdl.v5i1.12657>
- Benitz, M. A. (2021). Teaching in the era of COVID-19: A reinvented course project for an ocean engineering course. In *Proceedings of 2021 ASEE Virtual Annual Conference Content Access* (Paper ID #32302). American Society for Engineering Education.
- Bower, M., Dalgarno, B., Kennedy, G., Lee, M. J., & Kenney, J. (2014). *Blended synchronous learning: A handbook for educators*. Office for Learning and Teaching, Department of Education Sydney, Australia.
- Bower, M., Dalgarno, B., Kennedy, G. E., Lee, M. J. W., & Kenney, J. (2015). Design and implementation factors in blended synchronous learning environments: Outcomes from a cross-case analysis. *Computers & Education*, 86, 1–17. <https://doi.org/10.1016/j.compedu.2015.03.006>
- Bower, M., Lee, M. J. W., & Dalgarno, B. (2017). Collaborative learning across physical and virtual worlds: Factors supporting and constraining learners in a blended reality environment. *British Journal of Educational Technology*, 48(2), 407–430. <https://doi.org/10.1111/bjet.12435>
- Brown, T., & Tenbergen, B. (2021). Teaching Software Quality Assurance (SQA) during COVID-19 using the HyFlex approach – Course design, results, and experiences. In *Proceedings of 2021 ASEE Virtual Annual Conference Content Access*. American Society for Engineering Education. <https://doi.org/10.18260/1-2--37820>
- Butz, N. T., & Askim-Lovseth, M. K. (2015). Oral communication skills assessment in a synchronous hybrid MBA programme: Does attending face-to-face matter for US and international students? *Assessment & Evaluation in Higher Education*, 40(4), 624–639. <https://doi.org/10.1080/02602938.2014.940577>
- Butz, N. T., Stupnisky, R. H., & Pekrun, R. (2015). Students' emotions for achievement and technology use in synchronous hybrid graduate programmes: A control-value approach. *Research in Learning Technology*, 23. <https://doi.org/10.3402/rlt.v23.26097>
- Cheng, C., Kirby, C. K., Fu, J., Kelly, S., & Vandepol, N. (2023). Instructor challenges, strategies, and satisfaction in blended courses: A case study. *TechTrends*. <https://doi.org/10.1007/s11528-023-00884-4>
- Corzo-Zavalet, J., Yon-Alv, R., Icho-Yacupom, J., Somoza, Y. P., Andrade-Arena, L., & Vargas-Cuentas, N. I. (2023). Hybrid learning in times of pandemic Covid-19: An experience in a Lima university. *International Journal of Engineering Pedagogy*, 13(1), 65–81. <https://doi.org/10.3991/ijep.v13i1.36393>
- Daniel, B. K., & Harland, T. (2018). *Higher education research methodology: A step-by-step guide to the research process* (1st ed.). Routledge.
- Deci, E. L., & Ryan, R. M. (2012). Self-determination theory in health care and its relations to motivational interviewing: A few comments. *The International Journal of Behavioral Nutrition and Physical Activity*, 9(1), Article 24. <https://doi.org/10.1186/1479-5868-9-24>
- Egbue, O., Al-Hammoud, R., & Khan, A. (2022). COVID-19 and the new normal in engineering and computer science education: Students' perspectives on online and hybrid education. In *Proceedings of ASEE Annual Conference and Exposition 2022*. American Society for Engineering Education.
- Fabula, J. B. (2023). Hybrid learning experiences of college students with special education needs. *IAFOR Journal of Education*, 11(3), 29–49. <https://doi.org/10.22492/ije.11.3.02>
- Giacosa, A. (2023). Comparing the experiences of university teachers and students in synchronous hybrid settings during and after the pandemic. *RICOGNIZIONI. Rivista Di Lingue E Letterature Straniere E Culture Moderne*, 10(19). <https://doi.org/10.13135/2384-8987/7480>
- Graham, C. R. (2006). Blended learning systems: Definition, current trends, and future directions. In C. J. Bonk & C. R. Graham (Eds.), *Handbook of blended learning: Global perspectives, local designs* (pp. 3–21). Pfeiffer Publishing.
- Hamlin, A. J., Kempainen, A., Singer, A. M., Manser, N. D., Jarvie-Eggart, M. E., & Thiemann, K. (2021). Engaging students in synchronous, remote, or hybrid first-year engineering courses. In *Proceedings of 2021 ASEE Virtual Annual Conference Content Access*. American Society for Engineering Education. <https://doi.org/10.18260/1-2--37047>
- Handle-Pfeiffer, D., Winter, C., Löw, C., & Hackl, C. (2022). Rethinking hybrid teaching: The hybrid rhombus model as an approach to understanding hybrid settings. In J. Domenech (Ed.), *Proceedings of the 8th International Conference on Higher Education Advances* (pp. 1367–1375). Editorial Universitat Politècnica de València. <https://doi.org/10.4995/HEAD22.2022.14602>
- Hayes, S., & Tucker, H. (2021). Using synchronous hybrid pedagogy to nurture a community of inquiry: Insights from a tourism Master's programme. *Journal of Hospitality, Leisure, Sport & Tourism Education*, 29, 100339. <https://doi.org/10.1016/j.jhlste.2021.100339>

- He, H., Hunt, H. K., & Strobel, J. (2020). Switching modalities: An empirical study of learning outcomes and learners' perceptions in a hybrid bioengineering course. *International Journal of Engineering Education*, 36(3), 901–918.
- Head, R. (2016). The hybrid education material/immaterial space: Remote learning and teaching in Alice Springs. *The International Journal of Learning in Higher Education*, 23(3), 1–17. <https://doi.org/10.18848/2327-7955/CGP/v23i03/1-17>
- Heilporn, G., & Lakhali, S. (2021). Converting a graduate-level course into a HyFlex modality: What are effective engagement strategies? *The International Journal of Management Education*, 19(1), 100454. <https://doi.org/10.1016/j.ijme.2021.100454>
- Hu, Y., Shen, J., Hou, R., & Huang, H. (2022). Formative assessment for hybrid course in smart classroom: A cognitive presence perspective. In *Proceedings of 2022 International Conference on Intelligent Education and Intelligent Research* (pp. 262–265). IEEE. <https://doi.org/10.1109/IEIR56323.2022.10050039>
- Huang, Y., Zhao, C., Shu, F., & Huang, J. (2017). Investigating and analyzing teaching effect of blended synchronous classroom. In *Proceedings of 2017 International Conference of Educational Innovation through Technology* (pp. 134–135). IEEE. <https://doi.org/10.1109/EITT.2017.40>
- Huizinga, T., Lohuis, A., Zwerver-Bergman, J., & van der Meer, R. (2022). Student and teacher perceptions of community of inquiry in hybrid virtual classrooms. *Heliyon*, 8(12), e12549. <https://doi.org/10.1016/j.heliyon.2022.e12549>
- Irani-Kermani, R., Chen, D., Wolfskill, L. A., Nair, S. S., & Bullion, A. N. (2021). Students' perceptions in a hybrid learning model during the 2020 Covid-19 pandemic. *NACTA Journal*, 65, 132–143. <https://www.istor.org/stable/27157895>
- Irvine, V. (2020). The landscape of merging modalities. *EDUCAUSE Review*, 55(4). <https://er.educause.edu/articles/2020/10/the-landscape-of-merging-modalities>
- Krishnan, J., & Nagaratnam, S. (2023). Hybrid learning: A boon or bane. In *Proceedings of 2023 11th International Conference on Information and Education Technology* (pp. 256–261). IEEE. <https://doi.org/10.1109/ICIET56899.2023.10111373>
- Kyrkjebø, E., & Stoelen, M. F. (2023). Student perspectives on online hybrid learning in an undergraduate robotics course. In R. Lyng, J. Bennedsen, L. Bettaieb, N. R. Bodsberg, K. Edstrom, M. S. Guðjónsdóttir, J. Roslöf, O. K. Solbjørg & G. Øien (Eds.), *Proceedings of the 19th International CDIO Conference* (pp. 602–613). NTNU SEED.
- La Rosa, A. D., & Mavroudi, A. (2022). A case study of hybrid learning in higher education using quantitative research design. In J. Domenech (Ed.), *Proceedings of the 8th International Conference on Higher Education Advances* (pp. 943–950). Editorial Universitat Politècnica de València. <http://dx.doi.org/10.4995/HEAd22.2022.14680>
- Lakhali, S., Mukamurera, J., Bédard, M.-E., Heilporn, G., & Chauret, M. (2020). Features fostering academic and social integration in blended synchronous courses in graduate programs. *International Journal of Educational Technology in Higher Education*, 17, 5. <https://doi.org/10.1186/s41239-020-0180-z>
- Lakhali, S., Mukamurera, J., Bédard, M. E., Heilporn, G., & Chauret, M. (2021). Students and instructors perspective on blended synchronous learning in a Canadian graduate program. *Journal of Computer Assisted Learning*, 37(5), 1383–1396. <https://doi.org/10.1111/jcal.12578>
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174.
- Li, K. C., Wong, B. T. M., Kwan, R., & Wu, M. (2023). Learning in a hybrid synchronous mode: Experiences and views of university students. *International Journal of Innovation and Learning*, 34(2), 197–207. <https://doi.org/10.1504/IJIL.2023.132756>
- Li, K. C., Wong, B. T. M., Kwan, R., Chan, H. T., Wu, M. M. F., & Cheung, S. K. S. (2023). Evaluation of hybrid learning and teaching practices: The perspective of academics. *Sustainability*, 15(8), Article 6780. <https://doi.org/10.3390/su15086780>
- Li, N., Purwanto, E., Zhang, X., Cao, F., Wong, K. H., & Chen, X. (2024). Understanding the perceived pedagogical value of JazzQuiz in interactive hybrid learning among university students: A technology acceptance analysis. *Interactive Learning Environments*, 32(5), 1860–1876. <https://doi.org/10.1080/10494820.2022.2129393>
- Li, N., Zhang, X., & Limniou, M. (2021). A country's national culture affects virtual learning environment adoption in higher education: A systematic review (2001–2020). *Interactive Learning Environments*, 31(7), 4407–4425. <https://doi.org/10.1080/10494820.2021.1967408>
- Li, R., & Bringardner, J. (2021). Understanding remote student motivation in hybrid and remote engineering lab modes. In *Proceedings of 2021 ASEE Virtual Annual Conference Content Access*. American Society for Engineering Education.
- Lidstone, J., & Shield, P. (2010). Virtual reality or virtually real: Blended teaching and learning in a master's level research methods class. In Y. Inoue (Ed.), *Cases on online and blended learning technologies in higher education: Concepts and practices* (pp. 91e111). Information Science Reference. <https://doi.org/10.4018/978-1-60566-880-2.ch006>
- Lightner, C. A., & Lightner-Laws, C. A. (2016). A blended model: Simultaneously teaching a quantitative course traditionally, online, and remotely. *Interactive Learning Environments*, 24(1), 224–238. <https://doi.org/10.1080/10494820.2013.841262>
- Linville, C., & Wallen, B. M. (2022). Effectiveness of a Hyflex teaching pedagogy in environmental engineering education on student performance and course outcomes. In *Proceedings of ASEE Annual Conference and Exposition 2022*. American Society for Engineering Education. <https://doi.org/10.18260/1-2--40708>

- Lorenzo-Lledó, A., Lledó, A., Gilabert-Cerdá, A., & Lorenzo, G. (2021). The pedagogical model of hybrid teaching: Difficulties of university students in the context of COVID-19. *European Journal of Investigation in Health, Psychology and Education*, 11(4), 1320–1332. <https://doi.org/10.3390/ejihpe11040096>
- Marchisio, M., Rabellino, S., Roman, F., & Sacchet, M. (2022). Valuable features of hybrid teaching in a higher education context. In T. Väljataga & M. Laanpere (Eds.), *Shaping the digital transformation of the education ecosystem in Europe* (pp. 16–21). Springer, Cham. https://doi.org/10.1007/978-3-031-20518-7_2
- Marey, A., Goubran, S., & Tarabieh, K. (2022). Refurbishing classrooms for hybrid learning: Balancing between infrastructure and technology improvements. *Buildings*, 12(6). <https://doi.org/10.3390/buildings12060738>
- Martín-del-Pozo, M., & Martín-Sánchez, I. (2022). Self-assessment and pre-service teachers' self-regulated learning in a school organisation course in hybrid learning. *Journal of Interactive Media in Education*, 2022(1). <https://doi.org/10.5334/jime.745>
- Morris, S. A., Boyce, H., Ghio, C., Dee, A., Pathwick-Paszyc, A., DiMilla, P., & Reisberg, R. (2021). Hybrid learning: For better or worse? The effect of hybrid learning on grades and attitudes of first-year engineers in chemistry. In *Proceedings of 2021 ASEE Virtual Annual Conference Content Access*. American Society for Engineering Education.
- Moura, A., Graça, A., Macphail, A., & Batista, P. (2023). Student's perspectives about their learning profile before and after Covid-19. *Retos*, 48, 235–243. <https://doi.org/10.47197/retos.v48.95636>
- Niksiar, P., Bubacz, M., Ragan, D., Elamin, G., & Bass, P. (2021). Emerging ways to conquer education challenges in times of COVID-19 and their influence on students' academic performance. *Journal of Higher Education Theory and Practice*, 21(13), 215–227. <https://doi.org/10.33423/jhetp.v21i13.4802>
- Öberg, L.-M., Nystrom, C., Hrastinski, S., Mozelius, P., & Mid, J. (2019). Interaction and group work in blended synchronous higher education: Exploring effects on learning outcomes, satisfaction and retention. In *Proceedings of the 18th European Conference on e-Learning, 2019*. Academic Conferences and Publishing International Ltd. <https://doi.org/10.34190/EEL.19.036>
- Olt, P. A. (2018). Virtually there: Distant freshmen blended in classes through synchronous online education. *Innovative Higher Education*, 43(5), 381–395. <https://doi.org/10.1007/s10755-018-9437-z>
- Ørngreen, R., Levinsen, K., Jelsbak, V., Møller, K. L., & Bendsen, T. (2015). Simultaneous class-based and live video streamed teaching: Experiences and derived principles from the bachelor programme in biomedical laboratory analysis. In A. Jefferies & M. Cubric (Eds.), *Proceedings of 14th European Conference on e-Learning ECEL-2015* (pp. 451–459). Academic Conferences International.
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews*, 10(1), 89. <https://doi.org/10.1186/s13643-021-01626-4>
- Paiva, C. V., Cantarutti, C., & Garcia-Huidobro, R. (2021). Implementing and evaluating hybrid classes in a biostatistics course for dentistry. In *Proceedings of 2021 Machine Learning-Driven Digital Technologies for Educational Innovation Workshop* (pp. 1–5). IEEE. <https://doi.org/10.1109/IEEECONF53024.2021.9733768>
- Pavlidou, I., Dragicevic, N., & Tsui, E. (2021). A multi-dimensional hybrid learning environment for business education: A knowledge dynamics perspective. *Sustainability*, 13(7). <https://doi.org/10.3390/su13073889>
- Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). *Contemporary Educational Psychology*, 36(1), 36–48. <https://doi.org/10.1016/j.cedpsych.2010.10.002>
- Perry, R. P., Hladkyj, S., Pekrun, R. H., & Pelletier, S. T. (2001). Academic control and action control in the achievement of college students: A longitudinal field study. *Journal of Educational Psychology*, 93(4), 776–789. <https://doi.org/10.1037/0022-0663.93.4.776>
- Pham, A. T. V., & Pham, C. M. (2022). Students' perceptions towards hybrid learning during the Covid-19 pandemic. In *Proceedings of the 6th International Conference on Digital Technology in Education* (pp. 25–30). ACM. <https://doi.org/10.1145/3568739.3568744>
- Pham, A. T. V., & Tran, T. H. (2022). Teachers' perceptions of synchronous hybrid teaching during the Covid-19 pandemic. In *Proceedings of the 8th International Conference on Frontiers of Educational Technologies* (pp. 92–96). ACM. <https://doi.org/10.1145/3545862.3545878>
- Phelps, C., & Moro, C. (2022). Using live interactive polling to enable hands-on learning for both face-to-face and online students within hybrid-delivered courses. *Journal of University Teaching & Learning Practice*, 19(3), 08. <https://doi.org/10.53761/1.19.3.08>
- Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, 82(1), 33–40. <https://doi.org/10.1037/0022-0663.82.1.33>
- Pohl, A., Gehlen-Baum, V., & Bry, F. (2011). Introducing Backstage—a digital backchannel for large class lectures. *Interactive Technology and Smart Education*, 8(3), 186–200. <https://doi.org/10.1108/17415651111165410>
- Potter, A., & Blundell, C. (2022). Blended tutorials: Blended synchronous learning in mathematics. *MSOR Connections*, 20(2), 8.
- Pramila-Savukoski, S., Kärnä, R., Kuivila, H. M., Oikarainen, A., Törmänen, T., Juntunen, J., Järvelä, S., & Mikkonen, K. (2023). Competence development in collaborative hybrid learning among health sciences students: A quasi-experimental mixed-method study. *Journal of Computer Assisted Learning*, 39(6), 1919–1938. <https://doi.org/10.1111/jcal.12859>

- Qiao, W., Li, M., & Li, R. (2023). Beyond tech: The impact of hybrid classroom climate on the learning outcomes of university students. *Frontiers of Education in China*, 18(3), 288–309. <https://doi.org/10.3868/s110-008-023-0023-2>
- Rabb, R. J., Eggleston, A. G., & Welch, R. W. (2022). Hyflex for successful student veteran engineering education: Say it like you mean it. In *Proceedings of ASEE Annual Conference and Exposition 2022*. American Society for Engineering Education.
- Raes, A. (2022). Exploring student and teacher experiences in hybrid learning environments: Does presence matter? *Postdigital Science and Education*, 4(1), 138–159. <https://doi.org/10.1007/s42438-021-00274-0>
- Raes, A., Detienne, L., Windey, I., & Depaepe, F. (2019). A systematic literature review on synchronous hybrid learning: Gaps identified. *Learning Environments Research*, 23(3), 269–290. <https://doi.org/10.1007/s10984-019-09303-z>
- Richard, J. C., & Moore, J. M. (2022). Student performance impacted from modifying a first-year/semester engineering core course during a global pandemic. In *Proceedings of 2022 IEEE Frontiers in Education Conference* (pp. 1–9). IEEE. <https://doi.org/10.1109/FIE56618.2022.9962552>
- Rodriguez-Paz, M. X., González-Mendivil, J. A., Zamora-Hernández, I., & Núñez, M. E. (2022). A flexible teaching model with digital transformation competences for structural engineering courses. In *Proceedings of 2022 IEEE Global Engineering Education Conference* (pp. 1374–1380). IEEE. <https://doi.org/10.1109/EDUCON52537.2022.9766671>
- Rodriguez-Paz, M. X., Gonzalez-Mendivil, J. A., Zamora-Hernandez, I., & Zarate-Garcia, J. A. (2021). Students perceptions of a hybrid and flexible teaching model for post-COVID19 normality. In *Proceedings of the ASME 2021 International Mechanical Engineering Congress and Exposition. Volume 9: Engineering Education*. ASME. <https://doi.org/10.1115/IMECE2021-71742>
- Romaniuk, M. W., & Łukasiewicz-Wieleba, J. (2022). Hybrid education in higher education on the example of academic teachers' experiences in post-pandemic reality. *International Journal of Electronics and Telecommunications*, 68(3), 489–496. <https://doi.org/10.24425/ijet.2022.141265>
- Romero-Hall, E., & Ripine, C. (2021). Hybrid flexible instruction: Exploring faculty preparedness. *Online Learning Journal*, 25(3), 289–312. <https://doi.org/10.24059/olj.v25i3.2426>
- Samson, P. J. (2020). Student behaviors in a blended synchronous course. *Journal of Geoscience Education*, 68(4), 324–333. <https://doi.org/10.1080/10899995.2020.1768002>
- Sanchez, D., Kerzmann, T., Chouinard, C., & Kotchey, G. (2021). Assessing the Effectiveness of a Flex Model for a Sustainability Course in the COVID-19 Learning Environment. In *Proceedings of 2021 ASEE Virtual Annual Conference Content Access*. American Society for Engineering Education. <https://doi.org/10.18260/1-2--36712>
- Setiawan, R., Princes, E., Tunardi, Y., Chandra, A., Mursitama, T. N., & Limto, D. (2022). Assessing the impacts of IT usage, IT adoption, and innovation capabilities in increasing the hybrid learning process performance. *International Journal of Learning, Teaching and Educational Research*, 21(4), 337–354. <https://doi.org/10.26803/ijlter.21.4.19>
- Shield, P., Atweh, B., & Singh, P. (2005). Utilising synchronous web-mediated communications as a booster to sense of community in a hybrid on-campus/off-campus teaching and learning environment. In H. Goss (Ed.), *Proceedings of the 22nd ASCILITE Conference* (pp. 607–614). Queensland University of Technology.
- Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The challenges of defining and measuring student engagement. *Educational Psychologist*, 50(1), 1–13. <https://doi.org/10.1080/00461520.2014.1002924>
- Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *Journal of Educational Psychology*, 100(4), 765–781. <https://doi.org/10.1037/a0012840>
- Smith, C., Onofre-Martínez, K., Contrino, M. F., & Membrillo-Hernández, J. (2021). Course design process in a technology-enhanced learning environment. *Computers & Electrical Engineering*, 93, Article 107263. <https://doi.org/10.1016/j.compeleceng.2021.107263>
- Stewart, A. R., Harlow, D. B., & DeBacco, K. (2011). Students' experience of synchronous learning in distributed environments. *Distance Education*, 32(3), 357–381. <https://doi.org/10.1080/01587919.2011.610289>
- Sunny, C. E., & Bucks, G. W. (2021). Remote and hybrid learning environments: A case for promoting student engagement. In *Proceedings of 2021 ASEE Virtual Annual Conference Content Access*. American Society for Engineering Education.
- Szeto, E., & Cheng, A. Y. N. (2016). Towards a framework of interactions in a blended synchronous learning environment: What effects are there on students' social presence experience? *Interactive Learning Environments*, 24(3), 487–503. <https://doi.org/10.1080/10494820.2014.881391>
- Tan, L., Balakrishnan, N., & Varma, N. (2022). Teaching ST concepts during a pandemic: Modes for engaging learners. *Asia Pacific Journal of Educators and Education*, 37(1), 157–179. <https://doi.org/10.21315/apjee2022.37.1.8>
- Tan, P. S. H., Seow, A. N., Choong, Y. O., Tan, C. H., Lam, S. Y., & Choong, C. K. (2024). University students' perceived service quality and attitude towards hybrid learning: Ease of use and usefulness as mediators. *Journal of Applied Research in Higher Education*, 16(5), 1500–1514. <https://doi.org/10.1108/JARHE-03-2023-0113>
- Trotter, J., & Qureshi, F. (2023). Student perspectives of hybrid delivery in a transnational education context during Covid-19. *Journal of Applied Learning and Teaching*, 6(1), 103–111. <https://doi.org/10.37074/jalt.2023.6.1.10>
- Usher, M., & Hershkovitz, A. (2024). From guides to jugglers, from audience to outsiders: A metaphor analysis of synchronous hybrid learning. *Learning Environments Research*, 27, 1–16. <https://doi.org/10.1007/s10984-023-09466-w>

- Uukkivi, A., Labanova, O., Petjarv, B., & Nouakas, K. (2022). How to support cooperation in hybrid learning? In J. Domenech (Ed.), *Proceedings of the 8th International Conference on Higher Education Advances* (pp. 299–306). Editorial Universitat Politècnica de València. <http://dx.doi.org/10.4995/HEAd22.2022.14484>
- Van der Rijst, R., Guo, P., & Admiraal, W. (2023). Student engagement in hybrid approaches to teaching in higher education. *Revista de Investigacion Educativa*, 41(2), 315–336. <https://doi.org/10.6018/rie.562521>
- Verdecchia, R., & Lago, P. (2023). Tales of hybrid teaching in software engineering: Lessons learned and guidelines. *IEEE Transactions on Education*, 66(3), 234–243. <https://doi.org/10.1109/TE.2022.3221802>
- Wang, M.-T., & Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: A longitudinal study of school engagement using a multidimensional perspective. *Learning and Instruction*, 28, 12–23. <https://doi.org/10.1016/j.learninstruc.2013.04.002>
- Wang, Q., Huang, C., & Quek, C. L. (2018). Students' perspectives on the design and implementation of a blended synchronous learning environment. *Australasian Journal of Educational Technology*, 34(1). <https://doi.org/10.14742/ajet.3404>
- Wheele, T., Lindkvist, C., Weber, C., Windlinger, L., & Haugen, T. (2023). Studying the influence of technology on the social connectedness of students: A hybrid university learning environment (HULE). *IOP Conference Series: Earth and Environmental Science*, 1176, 012009. <https://doi.org/10.1088/1755-1315/1176/1/012009>
- Xiao, J., Sun-Lin, H. Z., Lin, T. H., Li, M., Pan, Z., & Cheng, H. C. (2020). What makes learners a good fit for hybrid learning? Learning competences as predictors of experience and satisfaction in hybrid learning space. *British Journal of Educational Technology*, 51(4), 1203–1219. <https://doi.org/10.1111/bjet.12949>
- York, D. (2015). Non-verbal immediacy's role in student learning. *Journal of Media and Communication Studies*, 7(1), 1–7. <https://doi.org/10.5897/JJMCS2014.0416>
- Zhao, X. (2023). Hybrid learning through lecture capture: Exploring perspectives and overcoming challenges with blackboard encore technology. *International Journal of Emerging Technologies in Learning*, 18(16), 210–221. <https://doi.org/10.3991/ijet.v18i16.42321>
- Zhong, Q., Wang, Y., Lv, W., Xu, J., & Zhang, Y. (2022). Self-regulation, teaching presence, and social presence: Predictors of students' learning engagement and persistence in blended synchronous learning. *Sustainability*, 14(9). <https://doi.org/10.3390/su14095619>

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