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Navigating Digital Transformations: Insights from eLFA 2023

Guest Editors

Ganthi Viswanathan
Renee Tan

Editorial Board

Contents

Editorial

Research articles

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Navigating digital transformations: Insights from eLFA 2023

Ganthi Viswanathan[A] A *Senior Lecturer, Online Learning, Singapore University of Social Sciences (SUSS), eLFA2023 Working committee member: Programme, Papers & Awards*

Renee Tan[B] B *Assistant Executive Director and Director of Research, Institute for Adult Learning (IAL), Singapore. Co-chair, eLFA2023 Organising Committee*

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This special issue of the Journal of Applied Learning and Teaching features papers selected from the eLearning Forum Asia (eLFA) 2023 conference.

eLFA 2023 was held at the Singapore University of Social Sciences from 30 November to 1 December 2023. Delegates from across Asia, including Singapore, Hong Kong SAR, the Philippines, China, and India, participated in the conference. A total of 51 oral presentations and 16 poster presentations were delivered, showcasing diverse perspectives and research contributions.

Each paper in this edition offers valuable insights into the evolving landscape of digital learning. Exploring themes such as student agency, generative AI, and digital tools, they reflect the conference's central theme, "Digital Futures of Work and Learning: Forging the Way Ahead."

- **Flipped learning in action: Seven cases from Singapore's Polytechnics**

  This paper examines seven case studies on the implementation of **flipped learning** across four Singaporean polytechnics. Twelve presenters from these polytechnics came together to collectively examine the sector-wide shift to flipped learning, highlighting shared challenges, innovations, and successes. The paper focuses on how these institutions leveraged technology and data-driven frameworks to promote self-directed learning—a critical skill for future employability. Key themes include the use of **learning analytics** to personalise support, the effectiveness of various **learning design models**, and the importance of **fostering social interaction** in both online and in-person learning environments. The authors conclude with practical recommendations for educators seeking to enhance flipped classroom initiatives, emphasising active learning while addressing challenges such as time constraints and student motivation. With insights drawn from a sector that enrols over 60,000 students, this paper provides valuable lessons for improving student engagement and learning outcomes.

- **Rethinking online assessments for adult learners – Exploring synchronous group presentations**

  In the age of AI, this paper addresses the increasing concerns about academic integrity and the implications of generative AI tools in education. It examines the transition from traditional written assignments to **synchronous group presentations** in an online undergraduate course for adult learners at the Singapore University of Social Sciences. This shift aims to promote authentic assessment while fostering essential communication skills. The study highlights the positive impact of this approach on student engagement, collaboration, and critical thinking, while also mitigating challenges posed by AI-generated content. The paper suggests strategies for optimising online group presentations, including leveraging technology for effective feedback, peer learning, and flexible scheduling to accommodate the unique needs of adult learners.

- **Investigating students' perspectives on the integration of generative artificial intelligence in university curricula and assessments**

  This paper explores the critical issue of integrating generative AI into higher education curricula and assessments, examining students' perspectives on its use. Conducted by academics at the Singapore University of Social Sciences, the study uses decision tree analysis to identify key factors influencing the acceptance of AI, including frequency of use and demographic

differences. It highlights both the benefits and challenges associated with GenAI adoption, advocating for a **balanced and ethical approach to integration**. The study emphasises the need for clear guidelines, ethical considerations, and a focus on developing critical thinking skills alongside technological proficiency to ensure responsible and effective use of AI in education.

- **Digital learning resources and student success: Analyzing engagement and academic performance**

  In an increasingly digitalised educational landscape, this paper analyses the impact of digital learning resources such as Learning Management Systems (LMS), e-textbooks, and study guides on student engagement and academic success at the Singapore University of Social Science. Through data-driven insights from over 1,500 undergraduate students, it underscores the importance of meaningful interaction with these tools to enhance learning outcomes. The findings provide actionable recommendations for optimising digital infrastructure and learning design.

- **ChemPOV: Evaluating a digital game-based learning tool for organic chemistry through student-researcher collaboration**

  This paper presents ChemPOV, a digital multiplayer game designed to enhance student engagement and understanding in organic chemistry. A hallmark of this initiative is the close collaboration between student researchers and educators at the National University of Singapore (NUS). The study highlights the transformative potential of **gamification** in STEM education, demonstrating how such tools can motivate learners and foster a deeper understanding of complex concepts. As a case study, it underscores the value of involving students as co-creators in educational innovations, offering practical insights for educators exploring digital game-based learning in STEM fields.

- **Fostering educational innovations in the era of global digital futures with students as partners (SaP) - Agency of university students in the Asian context**

  This paper explores the concept of student agency within the unique context of Asian higher education, particularly in Confucian-influenced settings. Conducted by researchers from five universities in Hong Kong and the Higher Education Research and Development Society of Australasia (HERDSA) Hong Kong Branch, the study examines factors influencing student agency, including cultural norms, pedagogical approaches, and the role of technology in shaping student experiences. The findings underscore the significance of **student-teacher partnerships**, **collaborative learning environments**, and a focus on **developing self-directedness** to empower students to take ownership of their learning.

Critical reflections and future considerations

The papers in this special edition collectively illuminate the ongoing digital transformation in higher education. They highlight several interconnected themes that warrant careful consideration as institutions navigate this evolving landscape.

The first notable theme centres on **digital infrastructure** and its integration into learning. The evidence presented suggests that thoughtful implementation of Learning Management Systems and digital resources can significantly impact student success. However, this raises important questions about how institutions can ensure meaningful engagement with these tools, specifically in the age of generative AI access.

A second prominent theme explores **pedagogical innovation,** particularly through flipped learning approaches. The successful cases from Singapore's polytechnics demonstrate how this model can foster self-directed learning while supporting student engagement. Yet, the sustainability and scalability of such approaches deserve further examination.

The emergence of **generative AI** presents both opportunities and challenges, as highlighted in several papers. While these tools offer new possibilities for learning and assessment, they also necessitate careful consideration of academic integrity and the development of critical thinking skills.

Perhaps most significantly, the papers collectively emphasise the importance of **student agency and partnership in educational innovation**. From game-based learning development to curriculum design, involving students as active participants rather than passive recipients appears to enhance both engagement and learning outcomes.

While the context of generative AI is new, many of the following questions build on longstanding themes in the literature, reflecting ongoing concerns in the field:

1. How can institutions balance the promise of data analytics with ethical considerations and student privacy?

2. What frameworks can guide the responsible integration of generative AI into curriculum and assessment design?

3. How might traditional power dynamics in higher education need to shift to better support student agency and partnership?

4. What role should industry partnerships play in shaping digital learning initiatives to ensure relevance for future workforce needs?

5. How can institutions ensure that digital transformation enhances rather than diminishes the human elements of learning?

6. What metrics should we use to evaluate the success of digital learning initiatives beyond traditional academic performance measures?

These questions invite deeper reflection on how institutions can navigate digital transformation while upholding core educational values and ensuring equitable access to quality learning experiences.

We are confident that the insights shared in this special edition will contribute meaningfully to the ongoing dialogue surrounding the digital transformation of education. By fostering collaboration, critical thinking, and adaptability, educators and institutions can prepare learners for the digital futures of work and learning, ensuring that education remains relevant, engaging, and impactful in an ever-changing world.

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Flipped learning in action: Seven cases from Singapore's Polytechnics

Paul J M Ng[A] A Ngee Ann Polytechnic, Singapore

Siew Kee Chong[B] B Singapore Polytechnic, Singapore

Guo Ren[C] C Senior Academic Mentor, Temasek Polytechnic, Singapore

Pratima Majal[D] D Temasek Polytechnic, Singapore

Shiying Cai[E] E Nanyang Polytechnic, Singapore

Yin Ni Annie Ng[F] F Nanyang Polytechnic, Singapore

Kim Sung Lee[G] G Ngee Ann Polytechnic, Singapore

Koon Guan Lee[H] H Temasek Polytechnic, Singapore

Lee Tyng Leong[I] I Ngee Ann Polytechnic, Singapore

Mark Wan[J] J Singapore Polytechnic, Singapore

Maria Teresa Abelanes[K] K Temasek Polytechnic, Singapore

Zhengping Liow[L] L Singapore Polytechnic, Singapore

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Correspondence

paul_ng@np.edu.sg [A]

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Abstract

Flipped learning reverses traditional direct instruction by having students complete homework before in-person classes. When supported by technology and data, flipped learning becomes a variant of blended learning, where blended learning refers to the integration of online and in-person learning experiences.

This paper highlights the sector-wide shift to flipped learning in Singapore's Polytechnics. The intent of the shift is to provide opportunities to improve self-directed learning, a critical skill set for the workforce. The authors consider seven presentations of practitioners' early studies of flipped learning in action, all of which were delivered at the e-Learning Forum Asia 2023 conference.

Key themes and takeaways from the seven presentations are considered, including the use of data and learning analytics to improve tailored support for self-directed learning, the value of learning-design models, examples of designing for social interaction during online asynchronous learning, to improve students' confidence in learning and operational challenges such as the need for more time to implement quality flipped learning.

The authors conclude with lessons for fellow practitioners to improve the designs of their own flipped learning efforts.

Introduction

Flipped learning is a variant of blended learning which "flips" or reverses the two-phase order of traditional direct instruction. Traditional direct instruction delivers foundational content to students in person and then leaves them to self-direct their learning with homework. Flipped learning helps students to self-direct their learning of foundational content before meeting peers and lecturers in-person for more personalised support to complete more complex "homework" together. Singapore's Polytechnics have adopted flipped learning in order to develop self-directedness as a key enabler of long-term employability. This article summarises, compares and draws lessons from seven early studies of flipped learning "in action" at four of Singapore's five Polytechnics. These studies were presented at the e-Learning Forum Asia 2023 ("eLFA 2023") conference in October 2023, organised in Singapore by the Singapore University of Social Sciences (Singapore University of Social Sciences, 2023).

Literature review

What flipped learning is: In flipped learning, initially termed the flipped classroom (Bergmann & Sams, 2012), students individually complete assigned homework, including watching pre-recorded lectures, before meeting their lecturers in person with the rest of their class. The "underlying logic" for flipped learning is that it is best – online and asynchronously – "to give students instruction on the content first" followed by "problem-solving, elaboration and mastery" in person (Kapur et al., 2022, p. 2).

Flipped learning is a variant of blended learning: When mediated by online technology, flipped learning is a variant of blended learning, where blended learning refers to various integrations of online and in-person learning experiences (Garrison & Kanuka, 2004).

Flipped learning improves learning outcomes: Compared to traditional direct instruction, appropriately designed flipped learning interventions produce significant gains for learning in higher education across academic, intra- and interpersonal, and satisfaction-related outcomes (Bredow et al., 2021). One reason for this is that lecturers use the data on students' individual progress as they actively self-direct their learning on foundational content to personalise the subsequent in-person learning support when students meet lecturers, peers and others to learn more complex content (Bergmann & Sams, 2023). Such data includes the results of online formative assessment checkpoints.

Blended learning, of which flipped learning is a variant, can develop self-directedness: Blended learning is both impacted by learners' self-directedness (Geng et al., 2019) yet can be designed to develop self-directedness, as recently affirmed by Singapore's own National Institute of Education (Natarajan, 2021).

Self-directedness is a valuable learning outcome: Self-directed learners are better at adapting to change, to learn new skills, to remain employed and to nurture their own long-term career success (Brandt, 2020).

Developing self-directedness has driven Singapore's shift to blended learning, including flipped learning at the Polytechnics: In 2022, Singapore's Minister for Education signalled to the country's education system the importance of continuing to develop self-directed learners coming out of the COVID-19 pandemic. Echoing the past several decades of research on self-directed learning (Brandt, 2020) and building on previous announcements to implement blended learning to further develop self-directed learners (Ministry of Education Singapore, 2020), the Minister stated that blended learning develops "students' capacity for self-directed learning" by allowing students to "learn to manage their time, and to prioritise and exercise initiative in learning outside the classroom… [t]his will be a critical skill for them as they go into the workplace as well - because learning goes beyond the classroom" (Chan, 2022, n.p.).

Singapore's five Polytechnics together enrol about 20000 new students each year for a total enrolment across the sector of about 60000 (Ministry of Education (ESD) Singapore, 2024). The Polytechnics offer 3-year diplomas with hands-on, practice-based learning experiences to prepare 17- to 19-year-olds for careers in the workforce and further education (Ministry of Education, Singapore, 2024). Although the Minister, in his 2022 speech had referred to other Singaporean educational institutions rather than the Polytechnics, the Polytechnics face the same or an even greater imperative to develop self-directedness given their mission as just described, since self-directed learning "will be a critical skill" for Polytechnic graduates "as they go into the workplace". Hence, the sector's adoption of flipped learning as a means to better support students to develop self-directedness in learning.

How flipped learning is implemented is important (details matter): Earlier research into lecturers' perceptions of flipped learning at Singapore Polytechnic shows that, to lecturers, instructional considerations have a significant impact on learning in flipped lessons (Or et al., 2022). The sector-wide shift into flipped learning has contributed to the evolution in the role and required skillsets of Polytechnic lecturers in Singapore, from Alison King's (1993) "sage-on-the-stage" to "guide-on-the-side". As Kapur and others have pointed out: "the nature of the implementation [of flipped learning] … matters significantly" (Kapur et al., 2022, p. 15). Merely flipping traditional direct instruction on students' timetables is insufficient to bring about changes in learning outcomes. All lecturers can take valuable learning-design lessons from the seven presentations featured here.

Flipped learning terminology at the Polytechnics in Singapore: The presentations from Singapore and Temasek Polytechnics employ the term "ALeRT". This term is defined at Temasek Polytechnic as "Assessing Learning in Real Time". It is defined at Singapore Polytechnic as "Assessing Learning Regularly for Timely feedback". ALeRT is not explicitly mentioned in the presentations from Ngee Ann and Nanyang Polytechnics. ALeRT began life in 2020 as an implementation of flipped learning that explicitly required data generated by students' learning activity to become a linchpin or key linkage-point between the two segments of flipped learning.

Initially promoted by Singapore and Temasek Polytechnics, ALeRT as a design concept was piloted and then adopted by all five Polytechnics in Singapore in 2021.

ALeRT is not only defined but also implemented differently at different Polytechnics. For example, Singapore Polytechnic's flipped learning design model envisages two ALeRT checks, whereas Temasek Polytechnic envisages three. Ngee Ann Polytechnic defines ALeRT as "Analytics on Learning for Responsive Teaching" and expects at least two checks. At Nanyang Polytechnic, ALeRT is also a two-check process. However, all ALeRT designs share two key characteristics: 1. the use of formative assessment-checks - typically but not exclusively quizzes - to generate data with which both lecturers and students themselves can evaluate students' grasp of content at various points in the flipped learning cycle; and 2. the use of that data to promptly tailor learning support for identified students or student-groups in subsequent stages of the flipped learning cycle, or in subsequent lessons in the semester, without having to wait for students to fail key summative assessments. The five Polytechnics are also continuing to experiment with effective and efficient ways to implement a third type of ALeRT check: confidence-in-learning. Confidence-in-learning is further discussed below.

Descriptive summary of the 7 eLFA 2023 presentations

Each presentation's conference abstract and slides are attached in the Appendix to this paper. For completeness and to better facilitate comparisons between the presentations, this summary also provides additional information not explicitly mentioned in the abstracts and slides, such as the number of survey respondents and focus group participants. The Polytechnics have adopted Brightspace by D2L (D2L Corporation, 2022) as the sector's Learning Management System (LMS) and all online learning activities occurred in the LMS unless otherwise stated.

Singapore Polytechnic delivered two presentations:

Singapore Polytechnic study 1 ("**SP 1**")

Abstract title (presentation titles may be slightly different): **Choose your own adventure: A pilot data-enabled flipped classroom study exploring learners' autonomy, self-efficacy and inquisitiveness**

Authors (not all authors presented): Zhengping Liow, Keith Yong Tze Tan and Wen Yi Ng

What was studied: Application of learner autonomy (Smith, 2008) to enable differentiated instruction in a data-enabled flipped learning design and its impact on aspects of students' self-directedness - self-efficacy (confidence in learning) and inquisitiveness.

Flipped learning design:

Online Asynchronous Learning: students completed quizzes embedded into content which lecturers analysed to identify "fuzzy points" of confusion.

In-Person: Students first worked in assigned pairs of stronger and weaker students on worksheets - less student autonomy – before stepping into group-based seminar activities and presenting their findings at the end of those activities - more student autonomy.

Research methodology: This study was conducted in one module with five classes and 110 students in the cohort. 72 respondent-students' data was analysed (n=72). T-tests were conducted on respondents'|paired "Type 1" (scaffolding activities with less autonomy) and "Type 2" (activities enabling more learner autonomy) survey items. Lecturers were not subjects.

Key findings: From "Type 1" to "Type 2", students' perception of their confidence in learning improved modestly, and inquisitiveness increased significantly.

Other noteworthy aspects:
This was one of the two SP studies that explicitly surveyed students on the impact of the learning activities on their confidence. SP 1 also explicitly described a scaffolded two-stage learning design and measured the impact of that design between the two scaffolds via a t-tested student survey.

Next steps: The authors hope to develop an active learning tool kit and models for differentiating instruction in flipped learning designs and to use validated instruments for further studies.

Singapore Polytechnic study 2 ("**SP 2**")

Abstract title (presentation titles may be slightly different): **Using data-enabled flipped learning to support differentiated instruction in a digital electronic engineering module**

Authors (not all authors presented): Siew Kee Chong and Mark Wan

What was studied: Lecturers and students' perceptions of Data-Enabled Flipped Learning and how it contributed evidence to differentiate teaching and learning in mixed-ability classrooms. Key reference was Tomlinson (Tomlinson, 2001).

Flipped learning design:

Online Asynchronous Learning: Students engaged in asynchronous lectures and completed quizzes. Quiz results were analysed to prepare for differentiated instruction in class.

In-Person: Differentiated learning experiences: high-performance students were challenged with stretch activities. Low-performance students received interventions to help them improve their understanding of the basic concepts.

Research methodology: This study was conducted in one module with 36 classes helmed by 20 lecturers. 648 students' data was analysed. The authors then conducted a survey of the students (n=203), lecturers (n=12), and separate focus groups with five students and five lecturers respectively.

Key findings: For students, their learning experience was largely positive although a few students queried the value of some of the learning activities. Lecturers obtained more precise insights and gave more targeted feedback to students but were concerned about the time necessary to analyse data and then design and develop differentiated instructions, the relevance of cohort- *vs* class-level statistics and the validity of the data in the LMS.

Other noteworthy aspects: This was one of the two SP studies that explicitly surveyed students on the impact of the learning activities on their confidence. This was also one of the three studies that obtained inputs from lecturers (the other studies were **TP 1** and **NP 1**).

Next steps: The authors are exploring the use of a customised chatbot to supplement learning materials and provide timely support to students.

Nanyang Polytechnic ("**NYP**") delivered one presentation.

Abstract title (presentation titles may be slightly different): **Igniting learner success: Unleashing the potential of the lectorial approach in flipped learning environments** - also known as "Enhancing Learner Engagement in a Flipped-Learning Environment Using the Lectorial Approach under NYP's DEFL Framework".

Authors (not all authors presented): Annie Yin Ni Ng, Shi Ying Cai, Terence Chin, Gia Wen Sim and Jia Ying Yong

What was studied: Implementation of the lectorial approach - which emphasises interactivity even in large lectures (Thalluri & Penman, 2020) in a flipped learning design.

Flipped learning design:

Online Asynchronous Learning: Students engaged with interactive online learning content e.g. online game, scenario-based learning. The content was closely linked to the in-person lessons which followed.

In-Person: Students performed hands-on activities to deepen or apply and demonstrate learning, including building models; interacting with physical items e.g. in laboratories; delivering group presentations and videos of processes.

Research methodology: This study was conducted on six modules in one School. Student survey n=221, 221 students' data was analysed. Lecturers were not subjects. Performance was measured across 3 quizzes, in a pre- and post-test research design - a pre-test before learning commenced, a 2nd test after the online but before the in-person segment, and a 3rd test after the in-person segment.

Key findings: The learning experience was largely positive. Students largely recognised the value of closely linking the online and in-person learning experiences and of interactivity in their learning experiences. Average marks improved quiz to quiz across all modules.

Other noteworthy aspects: The six modules chosen for this experiment were selected from different Diplomas to be representative of the whole School.

Next steps: Students suggested incremental improvements to the learning designs for lecturers' consideration. In response to those suggestions, lecturers committed to implementing improvements to their learning designs including enhancing the variety of activities, allocating more time to view e-materials, and adjusting the pace of in-person tutorials.

Ngee Ann Polytechnic delivered two presentations:

Ngee Ann Polytechnic study 1 ("**NP 1**")

Abstract title (presentation titles may be slightly different): **Learning through scenario in flipped learning context**

Author: Lee Tyng Leong

What was studied: Integrating scenario-based learning (Hussein Ahmed, 2019) into a flipped learning design, using Nearpod and Padlet.

Flipped learning design:
Online Asynchronous Learning: Completed online content including quizzes, games and simple scenarios presented in Microsoft Word.
In-Person: Applied or deepened learning via scenario-based learning.

Research methodology: 472 students experienced the design in one module. Student survey n=370. A focus group was conducted with five lecturers.

Key findings: The learning experience was largely positive. Lecturers found the design effective for facilitating productive in-person discussion provided students came prepared. In this sense, echoing **TP 1,** they were primarily concerned about how to improve self-directedness in students.

Other noteworthy aspects: This experiment used Nearpod for scenario-based learning. Nearpod enabled real-time tracking of student responses to facilitate in-depth discussions. Padlet was used to efficiently collect students' reflections at the end of their in-person lessons. The combination of these 2 tools enabled efficient and effective in-person scenario-based learning.

Next steps: The author identified the use of analytics to provide better support for students to complete their online asynchronous learning and strengthening lecturers' skills to facilitate in-person scenario-based learning, as challenges to address.

Ngee Ann Polytechnic study 2 ("**NP 2**")

Abstract title (presentation titles may be slightly different): **Enhancing engagement and interaction in online asynchronous learning**

Authors (not all authors presented): Kim Sung Lee and Gaik Bee Lim

What was studied: Application of the Community of Inquiry (CoI) framework (Garrison et al., 1999) and Feedback Fruits (Feedback Fruits, 2024) to improve online asynchronous learning experiences by facilitating online asynchronous collaboration.

Flipped learning design:
Online Asynchronous Learning: Students addressed challenges online learning content by discussing the content asynchronously using a 3rd party tool embedded into the LMS, called Feedback Fruits.
In-Person: Lecturer addressed students' online learning challenges as revealed by Feedback Fruits analytics, e.g. through further in-person discussion or practice on related past examination questions.

Research methodology: This study was conducted on one module. 36 students' data was analysed. A student survey was conducted, n=25. Performance in the form of grades in the related summative assessment (the module's final examination) was analysed across three semesters. Lecturers were not subjects.

Key findings: The learning experience was largely positive. There was no change in examinations performance over three semesters – two before intervention, and the semester of the intervention.

Other noteworthy aspects: This experiment used Feedback Fruits for more efficient and effective online asynchronous discussions. Students did not have to learn alone even though they were learning online.

Next steps: FeedbackFruits allows lecturers to seamlessly include model answers within online questions. This provides students with a valuable reference for self-assessment. Students shall be encouraged to better self-evaluate by comparing their responses to the model answers, to gain deeper insights into their understanding of the course content and further develop their self-directed learning skills.

Analysis and discussion

The clearest conclusion from the above is that, across the four presenting Polytechnics, after only one to two years into implementation, students had generally benefited well from flipped learning. Students' positive reception would have been in part due to causes well beyond this pedagogical change, such as the COVID-19 pandemic, the social-distancing impact of which compelled everyone, including students to develop at least some of the skills necessary for home-based and, therefore, self-directed learning – at least to a greater extent than fully-scheduled, in-person, synchronous, instructor-driven classes. However, the seven presentations also suggest the following learning-design themes that would have supported students to successfully self-direct their learning.

Temasek Polytechnic delivered two presentations:

Temasek Polytechnic study 1 ("**TP 1**")

Abstract title (presentation titles may be slightly different): **Enhancing student learning and engagement with data-enabled modified 5E model for flipped learning**

Authors (not all authors presented): Pratima Majal, Maria Teresa Abelanes, Siang Chuei Koo and Irene Chan

What was studied: The impact of the 5E model (Bybee & Landes, 1990) modified at TP for data-enabled flipped learning on a sample of both staff and students.

Flipped learning design:
Online Asynchronous Learning: Students engaged with learning triggers, explored learning content interactively, had foundational content explained, and evaluated their understanding through quizzes and other such checks.
In-Person: Students engaged with the results of the preceding online learning segment, had learning content elaborated upon, and had their deeper learning evaluated.

Research methodology: This study was conducted on three modules in two Schools. 1305 students experienced the designs. A survey was conducted with students (n=878) and lecturers (n=14).

Key findings: The learning experience was largely positive. Lecturers appreciated the impact of the 5E model on making flipped learning (Lo, 2017) more interactive and enabling them to track students' learning. They were concerned about how to improve self-directedness in students.

Other noteworthy aspects: The only cross-School study albeit still within the same Polytechnic. This was one of the three studies that obtained inputs from lecturers (the other studies were **SP 2** and **NP 1**).

Next steps: Lecturers wanted more support for lesson redesign and to develop in-person facilitation skills. Students asked for more practice (self-evaluation).

Temasek Polytechnic study 2 ("**TP 2**")

Abstract title (presentation titles may be slightly different): **A proof-of-concept study on the efficacy of agent-enabled nudge messages on learners' online learning behaviours**

Authors (not all authors presented): Koon Guan Lee, Ren Guo, Paul Cheung and Poh Nguk Lau

What was studied: Nudge theory (Weijers et al., 2021) to enhance viewership of recorded e-lectures and develop students' self-directedness.

Flipped learning design:
Online Asynchronous Learning: Students engaged in learning activities, such as watching recorded e-lectures and completing tutorial worksheets, that generated data in the LMS and video content management system (VCMS) and prompted the automatic sending of nudging messages.
In-Person: Lecturers checked in with students on their status of completion of e-lectures and tutorial worksheets, to reinforce the nudging messages sent through LMS. Details of these and other in-person learning activities were not described in the presentation as they were not the focus of the presentation.

Research methodology: This study was conducted in 1 module with 20 classes. 500 students' LMS and Panopto VCMS data was analysed for trends in:

1. the number of users that required nudging per Brightspace intelligent agent run; and
2. the number and duration of views of videos.

A student survey was also conducted, n=145. The authors also conducted focus groups with a total of ten students. Lecturers were not subjects.

Key findings: Data-triggered nudges helped students to complete online learning activities on time.

Other noteworthy aspects: This study focused exclusively on the online asynchronous learning portion of the flipped learning cycle, in particular the effect of the LMS' built-in "intelligent agent" tool to nudge students to complete asynchronous learning activities.

Next Steps: Based on students' feedback, authors will further optimise the design of the nudging activity by 1) reducing the nudging frequency; and 2) changing the means of delivering the nudging messages from Outlook email to Microsoft Teams.

Theme 1: Flipped learning as such does not work - but *active* flipped learning does

In 2022, Kapur and colleagues published a meta-study and critique of flipped learning, which asserted as follows (emphasis added in bold):

> The focus [of many studies of flipped learning] was more on engaging students in **repetitive, passive activities** — the **same in the pre-class repeated in the in-class**, usually via asking students to pre-review videos of classes, pre-review the PowerPoints then used in class, or listening to a teacher repeat material already exposed to the students. There is no reason to claim these are not worthwhile activities, but **it does not seem to be consistent with the claims of flipped learning for deepening understanding**... Our findings have revealed that such a two-phase model is not any more effective than a traditional model once the nature of implementations is considered. **What matters more is the inclusion of active learning** (Kapur et al., 2022, p. 14).

In the same paper, Kapur et al. proposed an active-learning four-phase alternative to two-phased flipped learning, namely the "Fail, Flip, Fix, Feed" model of productive failure first published by Kapur (2008). In this alternative model, "Fail" means to design a problem-solving trigger to diagnose what students understand and what they do not. "Flip" means to pre-expose students before their in-person lessons to foundational content – but it comes after "Fail". "Fix" means the lecturer in the in-person lesson should correct students' misconceptions as disclosed by "Fail" and ensure "robust" – which would include some aspects of self-directed learning. "Feed" refers to designing for formative assessment, including feedback.

One example of "Fail" might be at NYP, where students who participated in the study sat for a pre-test quiz, prior to commencing their "Flip" online asynchronous learning. This pretest was "productive" as it was rigorous – it revealed the extent to which students lacked knowledge. The pretest was both a diagnostic assessment and a motivational booster for students to "Fix and Feed" their gaps in person, working with their lecturers and each other.

Nonetheless, a problem-solving "Fail" diagnostic trigger was not a consistent key feature of the seven learning designs profiled here. Ironic as it may sound, productive *failure* should be a key feature of active flipped learning design going forward. However, in all other respects, the seven presentations here offer valuable lessons in "Flip, Fix and Feed" to support students' active – and, therefore, in various aspects, self-directed – learning at all phases of the flipped learning cycle. **SP 1** and **SP 2** used quizzes to detect students who "failed" in the online asynchronous learning phase - albeit during or after and not necessarily before the delivery of "Flip" foundational content – so that their self-directed learning issues could be "Fixed" in-person via lecturer- and peer-supported worksheet and group-based seminar activities. **NP 1** implemented simple "Flip" scenario-based learning to match students' self-learning abilities before stepping up into more complex scenarios to be "Fix"-ed collaboratively and in the presence of the lecturer. **NP 2** went a step further to provide students with the choice to seek collaborative assistance even during the "Flip" stage, ensuring that students did not have to wait to "Fix" their learning issues in-person. **TP 1** adopted a superficially different learning-design model (Bybee & Landes's 5E, adapted for data-enabled flipped learning) to marry interactive "Flip" with deeper-dive "Fix". **TP 2** showed how – "Fail" or otherwise – students can be nudged to self-direct their "Flip" for more meaningful in-person "Fix" learning. "Feed" formative assessments were embedded into both phases of flipped learning in all seven designs. None of these designs could be described as repetitive or passive. The point that Kapur, Hattie and their colleagues made in 2022 is accepted, that merely flipping on the timetable is insufficient. These seven designs provide useful examples of how to take advantage of that flipping in the timetable to improve active, self-directed learning.

Theme 2: Tailored support for students

The presentations show how the shift to flipped learning reduced the requirement for students – regardless of individual abilities and motivations – to move in "monkey see, monkey do" lockstep through rigidly-scheduled lessons. This shift allowed lecturers to "tailor" learning experiences in ways that encouraged students to actively construct their own learning, fundamentally by providing more time to students to learn at their own pace, but also by triggering students to plan, actively "do", and then evaluate their own learning. As pointed out in the context of a course designed to develop self-directedness in learners from disadvantaged backgrounds, such tailoring is key to helping students develop self-directedness (Mann & Willans, 2020).

One clear example of Theme 1 can be seen in **SP 1.** Lecturers tailored their support to their students' specific learning needs by designing diagnostic activities to discover what the students' difficulties were with the online content - the first segment of the flipped learning cycle. In-person, lecturers followed up by organising the cohort into "stretch" and "strengthen" groups and pairing different-ability students off to help stretch or strengthen the learning of foundational content via worksheets before the class proceeded to complete group presentations on a relevant topic of their choice. Students, therefore, received tailored support to demonstrate successively higher degrees of autonomy and learning as they progressed towards completing their group presentations.

The following are further examples of Theme 1:

SP 2: As in **SP 1**, the lecturers in **SP 2** grouped students into those who needed more support to achieve the outcomes at the baseline and those who could be stretched. They then followed up with differentiated activities for each group and ended with post-class assessments to gauge the effectiveness of the different interventions and identify areas for (differentiated) follow up: "Overall, the data suggest that students were positive to the various components of the initiative. The provision of variation in the learning activities, challenging goals, timely and helpful feedback, and clear

expectations for learning are all congruent with research on what teaching methods work best."

NP 1: Online, students were scaffolded through relatively easier scenarios, which were followed up in-person by more complex "branching" scenarios. Tailoring occurred primarily in-person, when students engaged in "do" scenario-based learning which the lecturer facilitated in real-time using Nearpod. Students' need-to-know continued to be triggered by linkages to real-life cases and the requirement to individually reflect on the impact of mistakes.

NP 2: The lecturer here drew on the Community of Inquiry (CoI) framework (Garrison et al., 1999) to guide learning from the side without resorting to direct instruction as his only aid. Students who otherwise might have struggled online and alone received help to learn as part of a community of fellow students and the lecturer via an efficient and effective collaboration platform (Feedback Fruits): "The teacher's presence, coupled with timely feedback and addressing student questions, is paramount for an effective online learning experience."

NYP: The online game "Robert's Asthma Journey" triggered both need-to-know and engagement and educated the students. Tailoring occurred when students demonstrated and developed their learning in-person through small-group presentations and student-created videos, for example on how to use inhalers. Students praised some ways in which their lecturers had designed their experiences to suit their needs so that they could better self-learn. Some examples of students' praise: "It was fun and I can understand how to use the different devices other than reading the steps". "I could discuss with my friends [as part of interactions during the lesson]". "I like how the lecturer allowed us to play with the models of atoms for us to better understand our e-materials".

TP 1: Via online delivery, lecturers tailored their support for different student profiles with a variety of age- and ability-appropriate triggers such as current news articles, videos, cartoon strips and questions worded in colloquial Singlish. Students then explored the online learning content using tools such as Padlet to consolidate their learning and evaluated that learning through quizzes. The quizzes generated data for lecturers to identify and address learning gaps on a differentiated basis. Further tailored support, as well as further elaboration or deepening of learning, occurred during in-person triggered activities such as crossword puzzles and through the subsequent small-group discussions leading up to the final evaluation activity.

TP 2: In a similar vein to NYP, students offered praise for their lecturers' design of the nudging messages. These nudges helped students to manage their own time without actually doing it for them (e.g. "The timing of the emails are just nice as we normally would do tutorials 1-2 days before tutorial lesson."). They also encouraged and motivated students to complete their self-learning journeys (e.g. "I had two minutes of great joy after receiving the encouragement email"; "I felt motivated to watch the videos as I thought the lecturer sent the email personally").

Theme 3: Data used to tailor support

As has been pointed out by the Singapore Polytechnic research team (Or et al., 2022, p. 66):

> Research has indicated that learner outcomes will improve if instructors in higher education maximise students' learning experiences by using the implementation data to drive those decisions and effectively shift student accountability for learning using flipped methods (Brewer & Movahedazarhouligh, 2018).

The lecturers in these seven presentations used formative assessment results (e.g. quiz performance, as with **SP 1, SP 2** and **TP 1**) as well as utilisation data from the LMS, VCMS and LMS-embedded 3rd party tools such as Feedback Fruits (e.g. **NP 2, TP 2**) to decide how to tailor their designs to better-facilitate their students' self-directedness. For **NP 1,** the lecturer identified better use of analytics as a challenge to be addressed in future iterations of her design, but also described the use of learning analytics data to develop self-directedness in-person lessons, through Nearpod as a tool to help her monitor individual students' engagement and progress in real-time during relatively complex scenario-based learning discussions. For **NYP**, the researchers described how they used quiz data as part of a pre-test, post-test design to measure the change in learning performance at each stage of their design. For **NP 2,** the researchers also analyzed the module's examination performance data to see if achievement had improved (it had not).

A key takeaway from the above is that what used to be invisible in traditional direct instruction , that is the time, effort and nature of students' activities when they have to learn on their own through technology, is made relatively more visible to lecturers and data-enabled flipped learning. That data should not hurt if lecturers wish to know their students better in order to deliver more tailored or personalised assistance to help them develop self-directedness in learning among many other outcomes, . Of course, it is possible to "flip" the learning without technology (Saichaie, 2020) – and data never tells the whole story and may even mislead (Bulger, 2016) – nonetheless, these seven presentations illustrate how the ideal of personalising the learning for every student is brought closer by data-enabled flipped learning – more so than without it.

In addition to the key themes discussed above, what are some other lessons for learning design from these seven presentations?

Other lessons for learning design from the seven presentations

Find clear models to help improve design: ALeRT, with its explicit reliance on analytics for prompt and tailored in-semester learning support, has been described above as a model for flipped learning across the five Polytechnics. **SP 1, SP 2** and **TP 1** also described their respective Polytechnics' own internal models for implementing flipped learning. In the case of **SP 1** and **SP 2**, the model in question was

DEFL - Data-Enabled Flipped Learning. For **TP 1**, it was 5E - Engage Explore Explain Evaluate Elaborate. **NP 2** referred to the popular Community of Inquiry framework to explain why facilitating efficient online asynchronous collaboration improves learning experiences. NYP used the lectorial concept as a one-word summary for interactive learning design, whether online or in-person regardless of the size of the class. **TP 2** referred to nudge theory, which explicitly admits the value of appropriate reminders to help students successfully complete learning activities on their own. **NP 1** referred to scenario-based learning as an established pedagogical model around which to design flipped learning, from simple scenarios students can individually complete online to more complex scenarios to work through in small groups when they meet in-person. The lesson here is that clear pedagogical models help improve design. These can be institutionally developed based on literature or directly taken from the literature. And they are helpful because they are logical, evidence-based, and like good checklists for any other task, help lecturers to address all relevant considerations. Once lecturers detect gaps in their learning designs whether through students' feedback, fellow lecturers' inputs, LMS and/or academic performance data, they should regard it as time well-spent to conduct some research to find relevant models to address those gaps.

Design to help students make online asynchronous learning social: Social interaction helps students manage complexity as time is always precious (Goodhart, 2019). Social presence is a key element of the CoI framework. The in-person learning segment of the flipped learning cycle is where most collaboration (social interaction) occurs because that is when collaboration is most efficient and the need is greatest due to the complexity of the content. However, **NP 2** offers a good example of a learning design which facilitates asynchronous online collaboration as a means of learning support. Another example is NYP where students collaborated to produce content to share during in-person lessons. A key reminder for readers might be that collaboration is not antithetical to self-directedness, and that self-initiated collaboration is an indicator of self-directedness (Moore et al., 2007). How can lecturers improve their flipped learning designs - especially the online asynchronous learning segments - to help students learn better how to support their own learning through collaboration?

Improve students' confidence-in-learning: Confidence can be described as a "state of being certain about the success of a particular behavioural act". Confidence is "certainly required for success, but high confidence and low accuracy is a problematic combination" and "building confidence where confidence is low is important for academic success" (Atherton, 2015). Confidence-in-learning checks poll students on their self-perceived grasp of the learning content, as opposed to performance data such as their marks from responding to content-related quizzes. As mentioned above, the five Polytechnics are continuing to experiment with effective and efficient ways to implement confidence-in-learning checks. Of the seven presentations discussed here, **SP 1** and **SP 2** studied students' confidence in learning. For **SP 1**, students' confidence in learning seemed to have improved modestly by the end of their flipped learning experience, between the "Type 1" and "Type 2" activities, moving from less to more learner autonomy in the design. For **SP 2**, students were less agreeable relative to other survey items that data-enabled flipped learning gave them confidence in their learning. The authors attributed this to students' difficulties with self-assessing confidence. A simple direct comparison between **SP 1** and **SP 2** is problematic even though both modules studied are within the same Polytechnic. **SP 1** studied architecture students most of whom came into their diploma via Singapore's academic "O" levels route (for background on the "O" levels, see the Singapore Examinations and Assessment Board, 2024) whereas **SP 2** studied electrical and electronic engineering students the majority of whom came into their diploma with educational backgrounds that were vocational. These differences in student demographics alone may consistently yield different confidence ratings. Nonetheless, these two presentations remind readers that confidence in learning is a predictor of academic performance (Atherton, 2015). Designing flipped learning to improve students' confidence in learning is desirable. **SP 1** describes in some detail, a learning design that can build that confidence. **SP 2** contains a more general description of a design that differentiates instructional activities based on data, between different performance profiles.

Summary – Lessons for learning designers

In brief, what are the implications of the above for future flipped learning implementations in Singapore's Polytechnics and similar institutions elsewhere?

1. Design for Failure, as in Productive Failure. Flipped learning, properly designed, should "Fail" and thereby surface students' self-directed learning issues as early as possible for "Flip, Fix and Feed" interventions during the in-person learning phase.

2. Design flipped learning to develop self-directedness through the provision of tailored learning support, especially during in-person lessons, using data from online asynchronous lessons.

3. Clear pedagogical models help lecturers not to overlook key design considerations.

4. Learning is social; self-directedness does not require learners to learn entirely alone. Flipped learning designs would do well to encourage more collaboration, even online.

5. In view of the correlation between confidence and success, design to support students to become more confident about their learning, in addition to a focus on developing content knowledge as such.

We proceed to consider a few key limitations common to many of these seven studies.

Limitations: What could be improved in the designs of the studies presented here?

This segment extracts three common limitations from the seven presentations that would be valuable to address to improve the quality of future similar studies.

Obtain lecturers' inputs: **SP 2, NP 1** and **TP 1** were the three presentations out of the seven considered here that obtained inputs from lecturers on their respective Polytechnics' models for implementing flipped learning. In **SP 2** and **TP 1**, lecturers agreed that the models helped them to design more active learning, build strong linkages between online and in-person learning segments, provide more targeted feedback and effectively "close" the learning for students. In contrast, lecturers expressed concern over the amount of time needed to implement and facilitate good quality flipped learning in accordance with their respective models. **NP 1** and **TP 1** also surfaced lecturers' concerns over motivating students to complete their online asynchronous lessons. Adopting Brookfield's four lenses (Brookfield, 2017; see Brookfield et al., 2019), any future iteration of the other four studies could better inform the sector's learning about flipped learning by also obtaining lecturers' perspectives, as every presentation here already cites literature and provides the students' and authors' perspectives.

Commence trend analyses: All the survey results discussed here were single-point checks – that is, the survey was only conducted once - except for **SP 1**, which implemented a two-point design. Survey responses were very positive. This finding was a key contributor to the statement above with the clearest conclusion from the presentations discussed here is that students had generally benefited well from flipped learning. Going forward, every presentation team proposed the next steps. **SP 1** declared an intention to use validated instruments for further studies as its next step. Once a valid and reliable yet efficient instrument is chosen, repeating measurements with that instrument over time would be valuable to establish benchmarks against which to monitor the progressive impact of changes in students' learning experiences due to presenters' next steps.

Add a focus on the impact of flipped learning on students' academic performance, in addition to the focus on students' learning experience: Of the seven presentations, only **NP 2** and NYP studied the impact of their respective flipped learning interventions on academic performance. NYP measured students' performance in an experimental context using a three-point pre- and post-test design, while **NP 2** analyzed module grades before and after the intervention. Subsequent studies should measure both experience as well as performance for a more holistic picture of impact.

This segment ends by acknowledging that of the seven presentations, only NYP explicitly discussed its study-design limitations. For example, NYP cited among its limitations the fact that the study was limited to one topic per module, and the absence of statistical analysis of the quiz results. Of the other presentations, **NP 1** discussed challenges or "limitations" on the learning design rather than the study design, such as the need (for example) to improve the learning design by improving the tracking of gaps in learning before in-person lessons. The lesson from this for readers would be to remember to address their own studies' limitations, as an aid for others to consider how they might improve the design of their own.

Conclusion

These seven presentations provide lessons in study design and specific examples of learning design to incorporate into professional development programmes for fellow practitioners. As mentioned in the Introduction and Literature Review, the move to flipped learning is intended to provide the Polytechnics with opportunities to better develop self-directedness as a critical skill for employability in today's workplace. The presentations discussed here could be viewed as the initial stages of the sector's action research spiral (Kemmis et al., 2014) into flipped learning to develop such self-directedness.

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Appendix

Name of the Polytechnic Short reference for the presentation	Abstract Title (Presentation titles may be slightly different)	Authors (Not all authors presented)	Abstract and Link to Presentation
Singapore Polytechnic SP 1	Choose Your Own Adventure: A Pilot Data-Enabled Flipped Classroom Study Exploring Learners' Autonomy, Self-Efficacy And Inquisitiveness	Zhengping Liow, Keith Yong Tze Tan and Wen Yi Ng	**Abstract:** Flipped classrooms (FCR) are popular pedagogical strategies in higher education and their success is contingent on the effective use of class time. The 'one-size-fits-all' approach to FCRs' activity potentially led to disengagement among students, as identical activities may not adequately accommodate learners' varying comprehension levels from asynchronous lectures. Therefore, educators can capitalise on students' learning insights from the lecture's knowledge checks and reflections to tailor FCR activities. The experimental 'Data-enabled Flipped Learning' (DEFL) model leverages these data/insights to design differentiated instructional (DI) FCR activities. These activities, anchored by Learner Autonomy (LA), let students choose activities that interest them, potentially heightening their curiosity. Seventy-two first-year architecture students participated in a One-Group Pretest-Posttest pilot trial between two DEFL models. DEFL Type 1 utilises knowledge check quizzes to classify students into stronger and weaker groups. Using the 'Think-Pair-Share' approach, stronger students partner with weaker ones to work on standard worksheets together. These objective exercises are facilitated through hierarchical one-on-one teacher-student interactions and feedback. DEFL Type 2 analyses students' lecture reflections to identify recurring themes and surface as learning gaps to design appropriate DI activities. Students can choose between two tracks: deepening their knowledge through library research or exploring the campus to observe and document construction details. The learning process and environment were differentiated according to learners' affinity and readiness with the topic. A questionnaire focusing on self-efficacy and inquisitiveness was administered after both DEFL activities. The Paired T-test revealed that students' perception of their self-efficacy improved modestly ($p = 0.084$) from DEFL Type 1 ($M=4.076$) to DEFL Type 2 ($M=4.159$), while students' inquisitiveness increased significantly ($p = 0.05$) from DEFL Type 1 ($M = 4.173$) to DEFL Type 2 ($M = 4.263$). DEFL Type 2's collaborative setting may have boosted learning confidence, echoing Anwar's (2016) findings on group discussions' positive effects. Promoting LA nurtures students' inherent interests and curiosity, which is crucial for cultivating self-directed learners (Reio, 2004; Siddiqui et al., 2022), thus addressing the shortcomings of the one-size-fits-all FCR approach. Teaching style affects student engagement and curiosity (Inayat & Ali, 2020). Differentiated activities that align with diverse teaching methods and learning attributes can feasibly boost these traits. This study contributes to a growing body of FCR research whereby students' learning data potentially enhance their learning attributes. Furthermore, Li et al. (2019) reported strong links between self-efficacy and curiosity, paving trajectories for future investigations in DEFL DI & LA pedagogies. https://docs.google.com/presentation/d/1GpH2HtyIJaZs9AZ36EMbcg4ll7y1NFKk/edit?usp=sharing&ouid=104664837057766530115&rtpof=true&sd=true
Singapore Polytechnic SP 2	Using Data-Enabled Flipped Learning to Support Differentiated Instruction in a Digital Electronic Engineering Module	Siew Kee Chong and Mark Wan	**Abstract:** Singapore Polytechnic (SP) is moving towards a digital learning culture where lecturers use data on student performance to customise teaching and learning strategies. This paper presents an evaluation of a pilot study on Data-enabled Flipped Learning (DEFL), an approach that harnesses data in a flipped learning format to support differentiated instruction. The pilot was implemented in a Digital Electronic Engineering Module involving 36 classes, 20 lecturers and 648 students in the academic year 2022/23 Semester 2. The aim was the systematic utilisation of the Learning Management System (LMS), especially the learning analytics features, to extract, collate, and present key learning data on online assessment to allow for the lecturer to prepare for focused feedback and differentiated instructional activities in the face-to-face sessions. The methodology employed a mixed-methods approach, incorporating quantitative and qualitative instruments to gather data from both teaching faculty and students. The study aimed to understand the students' perceptions of DEFL and how it contributed to their learning. Additionally, the study explored how teaching faculty experienced the initiative in terms of their professional role, including their ability to identify student-specific learning gaps, provide effective feedback, and design differentiated instruction. The findings provided valuable insights into how both students and teaching faculty experienced this initiative, identifying the most useful (and less useful) aspect of the instructional approach employed. Overall, the data suggested that students responded positively to the various components of the initiative such as embracing challenging goals, being given clear expectations for learning, appreciating the variety in the learning activities, and the timely and helpful feedback provided by the lecturers. The faculty's response on the potential benefits of implementing DEFL can be described as largely positive as faculty appreciate the ability to customise learning for their students and helping students to understand key concepts more deeply by targeted feedback. In conclusion, this study has demonstrated that learning analytics can enhance the effectiveness and efficiency of providing timely focused feedback and the instructional remediation needed for meeting a wider range of student learning needs. Of equal importance, it is not just the technology provision that is important, but a pedagogy that is evidence-based, utilising methods that are known to enhance learning.

			https://docs.google.com/presentation/d/1dJN_goD8rTyG_yAsXhWXt1taLYD_CLMX/edit?usp=sharing&ouid=104664837057766530115&rtpof=true&sd=true
Nanyang Polytechnic **NYP**	Igniting Learner Success: Unleashing the Potential of the Lectorial Approach in Flipped Learning Environments	Annie Yin Ni Ng, Shi Ying Cai, Terence Chin, Gia Wen Sim and Jia Ying Yong	**Abstract:** This research addresses the challenges of learner engagement in flipped-learning environments by introducing the innovative **Lectorial Approach—a fusion of lecture and tutorial delivery aimed at fostering learner engagement on a large scale.** Over 200 learners from Nanyang Polytechnic's School of Applied Science, ranging from year 0 (Poly Foundation Programme) to year 2, participated in the study. Three quizzes were conducted: **pre-e-learning, post-e-materials, and following face-to-face activities.** Results revealed a remarkable average improvement of over 50% in quiz scores after learners engaged with e-materials, demonstrating the effectiveness of the Lectorial Approach in bridging learning gaps and enhancing comprehension. The learners' pre-e-learning quiz scores indicated that the e-material topics were initially new to most students. However, their scores significantly improved after engaging with the e-materials, showcasing the impact of the Lectorial Approach on knowledge acquisition and retention. Additionally, the post-face-to-face activities witnessed a minimum 10% improvement in quiz scores across **four out of six modules**, reaffirming the approach's positive impact on learner understanding. The interactive and engaging face-to-face sessions effectively complemented the e-learning materials, creating a holistic and immersive learning experience. Learners' **survey responses** expressed enthusiasm and excitement towards the Lectorial Approach, praising its interactive, enjoyable, and easily understandable nature. The engaging face-to-face activities were credited for stimulating heightened interest and motivation in the subject matter. The Lectorial Approach emerges as a transformative solution to elevate learner engagement in flipped-learning environments. By creatively redesigning lesson delivery, it nurtures a profound and immersive learning experience, bolstering learners' academic performance and confidence. As we navigate the evolving landscape of education, this research underscores the **Lectorial Approach**'s **potential to reshape the future of flipped learning**, fostering a generation of empowered and inquisitive learners. By harnessing the synergistic blend of technology and interactive activities, the Lectorial Approach redefines learners' interaction with course materials, fueling their passion for learning and inspiring a lifelong thirst for knowledge. The findings demonstrate the Lectorial Approach's efficacy in enhancing learner engagement, laying the groundwork for future innovations in flipped learning and learner-centered education.
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Ngee Ann Polytechnic **NP 1**	Learning through scenario in flipped learning context	Lee Tyng Leong	**Abstract:** **Introduction:** Traditional didactic teaching methods in pharmacology education poses challenges in learning extensive biomedical content with limited opportunities to discuss and apply theoretical knowledge in patient care. This study aimed to assess the effectiveness of using Scenario-Based Learning (SBL) in Flipped Learning (FL) context to address these issues. **Methods:** **Participants.** This study included **472** third-year Diploma in Nursing students from Ngee Ann Polytechnic taking the Integrated Nursing Science 3.1 module in April 2023 semester. **Procedures.** The FL approach required students to do self-paced online asynchronous learning (OAL), including online videos, self-check quizzes and interactive online games to grasp foundational theoretical concepts before in-person learning (IPL) sessions. During IPL sessions, lecturers facilitated discussion of difficult concepts and application of the acquired knowledge through SBL, using real-life scenarios like medication errors and adverse drug events. Simple branching scenarios were developed using Nearpod, allowing live student participation in class and critical decision-making based on the provided scenarios. Nearpod enabled real-time tracking of student responses to facilitate in-depth discussions. Students were asked to explain their chosen nursing action and probed to consider various variables that could alter the outcomes. After the discussions, students reflected and shared their learning on Padlet. **Results and Discussion:** Of the 472 students, 370 (78.4%) completed an online survey to provide feedback. The results showed that more than 84% of the participants strongly agreed and agreed that SBL in FL context promoted active learning; improved critical thinking, raised awareness of medication errors and preventive strategies and prepared them for real-world scenarios. These provide preliminary support for the efficacy of the current design and integration of SBL in FL. The OAL is designed to foster active engagement through interactive learning activities. The SBL stimulates critical thinking, encourages applications and contextualises learning in real-world clinical scenarios. The lecturers found Nearpod and Padlet effective for facilitating productive in-person discussion. It was postulated that students who did not complete the OAL or could not grasp the concepts might struggle during the IPL sessions that demanded higher order thinking. Hence, it is crucial for the students to complete OAL to enable meaningful participation in IPL. **Conclusion:** This presentation reflects on the efficacy of and challenges in the design and integration of **SBL in FL context** to enhance pharmacology education for nursing students and can potentially extend these to other theoretical modules to further enhance student learning. https://docs.google.com/presentation/d/1x6TVtighVzagY6apFyg1nsR76U6fb9Aw/edit?usp=sharing&ouid=104664837057766530115&rtpof=true&sd=true
Ngee Ann Polytechnic **NP 2**	Enhancing Engagement and Interaction in Online Asynchronous Learning	Kim Sung Lee and Gaik Bee Lim	**Abstract:** **Purpose:** Ngee Ann Polytechnic, Singapore, has adopted the flipped learning approach, where live lectures had been converted to online asynchronous learning (OAL) materials, while tutorials take place in person to deepen and apply the learning. The shift is intended to nurture self-directed learners, and provide flexibility to learn at their own pace. However, students learn in isolation, which may result in reduced student motivation and engagement in learning. To address this, interactivity was introduced into the OAL materials, and the impact on learning and engagement was studied. **Methods:** FeedbackFruits Interactive Document and Interactive Video tools were used in a Genomics & Proteomics module taken by final year students of the Diploma in Biomedical Science. Lecturer-generated questions were embedded into the lecture slides and videos. Students could ask questions by annotating the slides or at a timestamp in the video. The lecturer provided feedback and responded to the questions. After 5 weeks of OAL delivery using the interactive study materials, a survey was conducted to assess students' perceptions of their learning experience as

			well as usability and engagement in the module. **Results:** 25 of 36 students responded to the survey. Students agreed or strongly agreed that the interactivity improved their learning in OAL (23/25), motivation to learn in the OAL (20/25), engagement with learning materials (24/25), sense of being a part of a learning community (18/25) and better enabled feedback (22/25). Students appreciated the ability to post questions at specific points within interactive documents for quick clarification of doubts, and view other students' questions. One key finding was that enabling anonymous posts provided students with a safe environment to ask questions. Comparison
			of mid-semester common test results between the fully implemented OAL semester and the preceding two semesters showed no significant difference in mark distribution, indicating that student performance in the flipped learning delivery was not compromised. **Conclusions and future directions:** Although OAL is done as an individual activity, the use of the interactive features enabled and encouraged learner-lecturer interaction and peer learning through viewing other students' responses to lecturer's questions. One critical element was the lecturer's presence in providing consistent feedback and addressing students' queries. Future directions include providing sample answers to lecturer's questions for students to assess their own responses as well as encouraging learner-learner interactions. https://docs.google.com/presentation/d/1DbtrGQbesYi92S_HoKtWagmrOZLqCNms/edit?usp=sharing&ouid=104664837057766530115&rtpof=true&sd=true
Temasek Polytechnic **TP 1**	Enhancing student learning and engagement with Data-enabled modified 5E model for Flipped Learning	Pratima Majal, Maria Teresa Abelanes, Siang Chuei Koo and Irene Chan	**Abstract:** Flip learning has become a widespread pedagogical strategy for educators in the wake of the pandemic. With Flipped Learning, lecturers are faced with the crucial task of ensuring students learn and are engaged online as well as in class. However, engaging students, especially online, can be very challenging (Hew & Lo, 2018). Thus, Lesson design and facilitation become critical to enhancing student learning and engagement. One approach to lesson design involves incorporating Temasek Polytechnic's Data-enabled Flipped Learning model, which integrates the **5E Inquiry model** and leverages Learning Analytics for responsive teaching. This framework is designed to seamlessly integrate both the out-of-class and in-class components of a flipped learning lesson. The 5E model comprises the following phases Engage, Explore, Explain, Elaborate and Evaluate. This model is a well-established active learning inquiry-based model introduced by Bybee (1993) and has been incorporated into Flipped Learning design in recent years (Jensen, Kummer & Godoy, 2015; Svensson & Adawi, 2015; Lo, 2017; Lai & Hew, 2019). At Temasek Polytechnic, the use of Learning Analytics is an integral part of teaching students online as well as face-to-face by incorporating the learning analytics strategy called ALeRT. Thus, the Data-enabled Flipped Learning framework has
			been designed to incorporate the 5E model along with the learning analytics strategy to scaffold faculty in designing effective Flipped Learning lessons. This study focuses on implementing the **Data-enabled Flipped Learning framework** in **three subjects** in the School of Engineering and the School of Business at Temasek Polytechnic. Both the quantitative and qualitative data collection methods, such as **student surveys and interviews**, were used to gain a comprehensive understanding of the effectiveness of this framework in engaging
			the learners. The authors also share the insights gained from the experiences of the teaching teams involved in incorporating the framework in their flipped learning lessons. Through this study, we will share **examples of lessons that have been designed using the Data-enabled Flipped learning framework.** Additionally, we will explore the challenges faced by lecturers during implementation and the strategies they employed to overcome them. Moreover, feedback from students regarding their experience of learning in a flipped format will also be shared. https://docs.google.com/presentation/d/1dqsWU1vm7wJFuDY1WCOkoLvJ1B4AiwXF/edit?usp=sharing&ouid=104664837057766530115&rtpof=true&sd=true
Temasek Polytechnic **TP 2**	A proof-of-concept study on the efficacy of agent-enabled nudge messages on learners' online learning behaviours	Koon Guan Lee, Ren Guo, Paul Cheung and Poh Nguk Lau	**Abstract:** As flip learning gains traction in higher education (HE) courses in a post-COVID era, it is critical that instructors are able to monitor learners' learning progress and preparation for in-person classes. A common problem that lecturers at Polytechnics in Singapore face is that learners do not watch the asynchronous lecture videos and complete tutorial worksheets before coming to tutorial
			worksheets before coming to tutorial classes. To counter this problem, a proof-of-concept pilot was implemented to explore how autonomous email messages could nudge learners towards adopting such positive learning behaviour in a flipped learning environment. Three tutorial lessons in a freshmen level microbiology course (n = 487) were selected. Messages were configured using an intelligent agent (IA) tool in the Learning Management System (LMS) to deploy customised emails. Learners who did not watch the lecture videos received a reminder message two days before class. If they did not respond by watching the videos, another reminder email would be triggered one day before the
			scheduled class. To nudge learner action, links to the lecture videos, the tutorial worksheet and time management resources were embedded in the reminder emails. Encouragement emails were sent to learners who viewed the videos to reinforce positive learning behaviour. From LMS analytics, it was observed that there was a general decreasing trend in the number of learners who received reminders (meaning that they watched videos ahead of time) across the three tutorial sessions (from 48% to 42%), with the video analytics data showing a sharp upward spike in video views coinciding with the launch of the study. Post-survey results showed that majority of learners perceived the reminder and encouragement emails to be useful. Interestingly, despite the increased number of video viewers, a McNemar analysis of paired responses in pre- and post-surveys revealed an increased proportion of learners reported that they were not able to watch videos according to the course schedule. This could be explained either by enhanced learners' self-awareness from email reminders or confounding factors from the time of survey. Focus group discussions revealed that adoption of a personal and encouraging tone in the emails, provision of direct links to the learning resources, and strategically timed emails were the key factors in promoting learner actions. Overall, the IA reminders were considered effective as supported by the quantitative and qualitative data, showing the potential of such tools to promote self-awareness and desirable learning behaviour. https://docs.google.com/presentation/d/11pCf4sIojnbRyhlTAcgzwC9eX-NJqiIs/edit?usp=sharing&ouid=104664837057766530115&rtpof=true&sd=true

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Rethinking online assessments for adult learners: Exploring synchronous group presentations

Ganthi Viswanathan[A] [A] *Online Learning Unit, Singapore University of Social Science*

Boon-Yuen Ng[B] [B] *School of Business, Singapore University of Social Science*

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Correspondence

ganthimathi@suss.edu.sg [A]

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Abstract

This study explores the shift from written assignments to synchronous group presentations in a fully online marketing course at a Singapore institution for adult, part-time learners. The change, implemented in mid-2023, aimed to enhance engagement, develop essential skills, and address academic integrity issues arising from AI-generated content. Employing the Community of Inquiry framework which emphasises cognitive, social, and teaching presence, the pilot's effectiveness was assessed through mixed-method surveys involving both students and instructors. Despite perennial groupwork challenges such as scheduling conflicts and participation issues, the findings indicate that synchronous group presentations enhanced engagement and essential skills development in the digital age. The paper recommends incorporating asynchronous elements and additional support to optimise online group presentations. Although this is a small-scale study, its findings offer valuable insights for educators and institutions striving to enhance learning outcomes and mitigate overreliance on generative AI in assessments.

Introduction

The number of adult learners in higher education has been increasing in recent years, particularly with the COVID-19 pandemic's push to online learning (Fiorini et al., 2022). Adult learners in higher education are typically older than traditional college-age students. As they may be working or may have familial obligations (Bober & Dennen, 2001), online learning makes a significant difference to adult learners as it offers them the flexibility to pursue their education at a time and place that fits their schedule constraints (Lu et al., 2022; Ng, 2023). Studies suggested that part-time adult learners were satisfied with online learning as they were able to save on commuting time and view lecture recordings from the comfort of their own home (Fiorini et al., 2022). Nevertheless, academic integrity is a concern for adult learners, particularly in online or distance learning (Jocoy & DiBiase, 2006).

The rise of generative artificial intelligence (GenAI) tools like ChatGPT has exacerbated issues of plagiarism and compromised academic integrity in written assessments (OECD, 2023; Zhang et al., 2024). GenAI is capable of "generating seemingly new, meaningful content such as text, images, or audio from training data" (Feuerriegel et al., 2024, p. 111), making it difficult to distinguish from human work. GenAI has changed the assessment landscape of higher education, bringing multiple opportunities, such as generating feedback and conducting automatic marking (Chiu, 2024). However, it also presented challenges as students could submit AI-generated work for assessment purpose, passing it as their own (Luo, 2024). Indeed, instructors might not have the confidence or the ability to correctly identify the authorship of students' work (Murray & Tersigni, 2024).

Researchers have suggested that presentations and discussions as assessment types focus on higher-order thinking skills and may be less impacted by the use of GenAI (Smolansky et al., 2023). Although students could simply read off AI-generated scripts during online presentations, Nikolic et al. (2023) highlighted that GenAI tools could not take the place of students in real-time oral components that require quality interactions (e.g., questions and answer segments, reflections) suggesting higher integrity strength. Oral assessments also have the additional benefit of developing communication skills for students. Communication (the ability to share information effectively) and collaboration (the ability to work effectively with others) were listed as the top two critical core skills in a Singapore government report forecasting in demand and transferable skills over the next two years (SkillsFuture Singapore, 2023). This suggests that oral presentations that require students to demonstrate learning through presentations and interactions may address the need to develop critical transferable skills.

Hybrid and remote work arrangements are increasingly becoming the norm in a post-COVID environment (Tan, 2024). To prepare graduates for evolving workplaces, educational institutions must adapt their assessment methods accordingly. Incorporating synchronous presentations into the curriculum can offer students the opportunity to present and defend their work in real time, fostering critical thinking, presentation, and collaborative learning skills in a hybrid environment (Chen et al., 2009; Evans et al., 2024). These competencies are crucial in both academic and professional contexts. However, despite their potential to enhance employability, synchronous presentations remain underutilised as an assessment method (Hughes et al., 2024).

While individual synchronous oral assessments, such as viva voces, are effective in promoting academic integrity and preparing students for professional life (Sotiriadou et al., 2019), they present significant challenges when applied to large cohorts due to logistical constraints and resource demands. In contrast, asynchronous presentations offer flexibility, allowing students to participate at their convenience, which is particularly beneficial for adult learners facing time constraints. However, pre-recorded asynchronous presentations may fall short in developing students' real-time presentation skills and their ability to navigate the unique social dynamics and technical aspects of online presentations (Hughes et al., 2024).

A possible solution to manage large cohorts is to assess students based on group presentations instead of individual presentations. Synchronous group presentations with question and answer (Q&A) segments could develop students' presentation and collaborative learning skills and address growing concerns about the over-reliance on GenAI and its ethical implications in completing written assignments.

Although research has examined the effectiveness of the different learning modalities such as asynchronous, synchronous and face-to-face experiences (e.g., Hrastinski, 2008; Martin et al., 2021; Muller et al., 2019; Zeng & Luo, 2023), relatively fewer recent studies compare assessment types within online environments from instructors and adult learners' perspectives (see for example, Jung et al., 2023). This gap is evident in searches conducted through academic databases and tools such as Google Scholar, Research Rabbit.ai, and Inciteful.xyz. Addressing this gap as well as the challenges of GenAI, we seek to answer the following research questions:

1. How effective are synchronous group presentations?

2. How do instructors and students perceive the shift from written assignments to synchronous presentations?

3. What are the challenges of implementing synchronous group presentations in large online classes, and how can these be effectively mitigated?

This study evaluates synchronous group presentations as an assessment method to promote authentic learning and enhance academic integrity, reducing dependency on AI-generated content. It is guided by the Community of Inquiry framework, which supports the integrated development of cognitive, social, and teaching presences essential for meaningful learning experiences (ElSayad, 2023; Garrison et al., 2010). To increase relevance to professional skill development, the assessment is also guided by the Five-

Dimensional Framework for Authentic Assessment (AAF) (Gulikers et al., 2004). This addresses the gap between assessment tasks and work in the real world.

Through a case study of implementing synchronous group presentations in a university with adult learners, this research aims to understand the experiences and perceptions of both students and instructors, thereby offering valuable and practical insights when implementing synchronous group presentations as an assessment strategy. This study explores the potential of synchronous group presentations to maintain academic integrity and with the additional benefit of fostering critical skills such as communication and collaboration skills. Practical implications and recommendations are also drawn from this study to help higher education institutions develop and implement synchronous group presentations.

Theoretical background

Community of inquiry

Garrison et al. (1999) proposed that learning within the community takes place through the interaction of three components: cognitive presence, social presence and teaching presence. Together, the three components form a framework which can be used to guide the research of online learning in higher education (Garrison et al., 2010). Known as the Community of Inquiry, it is a theoretical framework that can be used to understand the underlying processes of student learning in online environments (Shea & Bidjerano, 2008).

Cognitive presence can be defined as "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication" (Garrison et al., 1999, p. 89). It involves four phases: (1) A trigger event in the learners' shared environment, which identifies an issue or a problem; (2) Exploration by learners, both individually and as a group; (3) Integration of ideas and content from the exploration phase; (4) Resolution, in which learners apply the new knowledge they have gained (Garrison et al., 2001).

In online learning, *social presence* refers to "the degree to which a communication medium allows group members to perceive (sense) the actual presence of the communication participants and the consequent appreciation of an interpersonal relationship, despite the fact that they are located in different places, that they may operate at different times, and that all communication is through digital channels" (Lowry et al., 2006, p. 633). It is about participants of the community presenting themselves as "real people" in the community (Garrison et al., 1999), leading to increased interaction, engagement and group cohesion (Garrison & Arbaugh, 2007; Lambert & Fisher, 2013).

Teaching presence refers to "the design, facilitation and direction of cognitive and social processes for the purpose of realising personally meaningful and educationally worthwhile learning outcomes" (Anderson et al., 2001, p. 5) and this is typically established by the instructor (Garrison et al., 1999). Teaching presence enhances cognitive presence and social presence to achieve educational outcomes.

Authentic assessment

Authentic assessment is critical to prepare students for the dynamic nature of the real world and stimulate students to develop skills or competencies which are aligned to the future world of work (Gulikers et al., 2006). It prepares students for their professional life and enhances their engagement in learning as they are expected to demonstrate the qualities of an expert employee of their field in their assessment (Sokhanvar et al., 2021).

Authenticity of the assessment can be understood as the similarity between the cognitive demands of the assessment and the cognitive demands of a related criterion situation which reflects a real-life situation (Savery & Duffy, 1995). To define authentic assessment, Gulikers et al. (2004) proposed the Five-Dimensional Framework for Authentic Assessment (AAF). The five dimensions are task, physical context, social context, assessment result or form, and assessment criteria. Each dimension is a continuum that varies in the level of authenticity.

An authentic *task* is one that "that resembles the criterion task with respect to the integration of knowledge, skills, and attitudes, its complexity, and its ownership" (Gulikers et al., 2004, p. 71). It should resemble a real-world task in terms of complexity and ownership of the task and the process of developing a solution.

The *physical context* of the task should reflect professional practice in terms of how knowledge and skills will be used (Gulikers et al., 2004). Similarly, the *social context* should reflect the social processes in real-life contexts. For example, if collaboration is required in a real-life situation, the assessment should also require collaboration (Gulikers et al., 2004).

Assessment result relates to the output of the assignment which should be a "quality product or performance that students can be asked to produce in real life" (Gulikers et al., 2004, p. 75). The output should be evaluated against *assessment criteria* that relate to a "realistic outcome, explicating characteristics or requirements of the product, performance, or solutions that students need to create" (Gulikers et al., 2004, p. 75). This means that the assessment criteria should be based on real-life situations and evaluate the development of relevant professional skills.

In their extensive review of authentic assessment literature, Ashford-Rowe et al. (2013) identified eight critical elements of authentic assessments. The authors underscored the importance of including metacognition, through self-assessment and critical reflection, to deepen learners' engagement and personal growth. They advocated for the integration of structured feedback opportunities, enhancing the original five dimensions by promoting reflective learning and continuous improvement in real-world contexts. Additionally, authentic assessment should promote knowledge transfer across different domains.

Methodology

Context

The study focused on a population of 340 part-time and full-time students enrolled in an online marketing course, along with 13 part-time instructors who each taught a class of up to 36 students. The marketing course was a foundation-level undergraduate course at a Singapore institution that served a significant number of part-time, adult learners. The course had been offered fully online even before the pandemic, with a cohort of approximately 300-350 students, with 30 to 36 students per class. The course instructors were mainly part-time lecturers with 10-15 years of face-to-face and online teaching experience. A course leader coordinated the teaching team to ensure consistency in curriculum delivery and assessment matters.

The course was structured around six synchronous online seminars held from 7pm to 10pm over a 12-week period, accommodating the schedules of working adults. Seminar recordings were made available. The course also supported asynchronous learning through study guides, additional resources, and discussion forums.

Traditional assessments had included quizzes, class participation, online discussion forums, individual and group written assignments, and a final exam. The written assignments required students to apply course concepts to analyse case studies of real-world marketing issues and submit a written analytical report proposing solutions. The group assignments, which did not require real-time meetings, allowed flexible peer-to-peer learning for part-time adult learners.

In early 2023, following the release of widely available GenAI tools like ChatGPT, the institution released guidelines allowing students to use GenAI tools for written take-home assignments for most courses, with stipulations for disclosure and acknowledgement to promote ethical and informed use (Rakshika & Lee, 2024). However, this approach was not without challenges and implications (Dwivedi et al., 2023; Wang et al., 2024).

The solution

A decision was made to introduce synchronous group presentations to replace the written group assignment. Synchronous group presentations had the potential of addressing the concern of academic integrity with the use of GenAI, and the added advantage of developing communication and presentation skills for marketing students.

The assignment consisted of a case scenario, in which the students represented a statutory agency, tasked with devising solutions for a chosen local organisation, selected on a first-come, first-served basis to promote engagement and ownership. Although it was a group assignment, it required students to work on their individual assessments before working on the group assessment, ensuring all students were prepared to contribute meaningfully to the group solution.

The new assessment was guided by the AAF (Gulikers et al., 2004) to ensure that the learning tasks closely mirror professional activities. This alignment not only enhanced the relevance of the tasks but also encouraged the application of theoretical concepts in real-world scenarios, thereby supporting deeper learning and skill development.

The first dimension, *task*, required student groups to play the role of executives at a local agency tasked to develop a marketing campaign proposal for selected organisations and present the proposal in a synchronous group presentation. This was similar to real-world scenarios where professionals must present and defend their ideas, applying knowledge, skills and attitude of marketing professionals. This design ensured cognitive presence, as students engaged deeply with content while preparing for real-world application.

The *physical context* of synchronous presentations in an online setting effectively simulated real-time interactions and resource usage typical in professional environments. While the simulation provided a relatively lower fidelity, "clean", and "safe" learning space, which was appropriate for a foundational course, the online group work requirements, as well as the largely part-time student cohort, created logistical and time-related challenges that students would need to deal with, similar to professional work. Synchronous presentations also challenged students to engage in independent research, fostering critical thinking about relevant and irrelevant information (Gulikers et al., 2004).

Group presentations enhanced collaboration and communication skills, aligning academic exercises with professional workplace demands, thus addressing the *social context* dimension. These activities promoted social interaction, positive interdependency, and individual accountability, crucial for workplace success and reflective of the social presence component of the Community of Inquiry framework (Garrison et al., 1999).

The *assessment result or form* requires students to demonstrate competencies by the creation of a quality solution to other people (Gulikers et al., 2004). For this assessment, students were required to deliver presentations and participate in Q&A sessions with a live audience. This format not only assessed their understanding and application of marketing concepts in real time, but also reinforced cognitive presence through active and participatory learning. Additionally, the Q&A or interview-type presentations aligned with academic integrity goals (Nikolic et al., 2023) and might reduce the reliance on AI-generated content (Ward et al., 2023).

The use of clear grading rubrics or *assessment criteria,* provided at the start of semester and discussed in class, ensured that students clearly understood the assessment and feedback expectations. This approach strengthened teaching presence, guiding students towards meaningful outcomes.

Implementation of the solution

Guided by the Community of Inquiry framework, the Head of Programme developed the initial grading rubrics focused on articulating and defending ideas and demonstrating a comprehensive understanding of the group's solution. These drafts were refined through two rounds of feedback from four senior course instructors to ensure clarity and alignment with course outcomes, particularly in presentation and group working skills.

Before the course commenced, all 13 instructors were briefed by the Course Leader and Head of Programme on the new assessment approach, including contingency plans for technical issues during presentations (e.g., options for rescheduling or recording presentations with live Q&A sessions). Throughout the semester, communication among instructors was maintained through WhatsApp and email, allowing for consistent lesson delivery while providing room for additional student support activities as needed.

Technological setup

The course sites on the Learning Management System (LMS) hosted all course announcements, materials, assessments and additional materials. The LMS was also used to facilitate group selection and allocation processes. Based on experience, many part-time adult learners did not check their school emails or LMS regularly. Most instructors maintained groups on messaging apps (Telegram or Whatsapp) as a backup communication channel for immediacy purposes. All synchronous seminar sessions were held over Zoom with recordings made available on the LMS. Synchronous presentations were also conducted through Zoom.

Managing synchronous assessment for large classes

Managing synchronous presentations for up to 36 students per class presented logistical challenges. To accommodate part-time students' schedules, presentations were spread across two weeks (refer to Table 1 for the two sessions) following a one-week break. Each group had a 20-minute presentation followed by a 10-minute Q&A session during the three-hour seminar slot. This schedule allowed for equitable access to presentation slots on a first-come, first-served basis, and all sessions were recorded and made available on the LMS.

To mitigate the potential advantage for groups presenting in the second session, all groups were required to submit their final slides one week after the second session of presentations, allowing groups who presented in the first session more time to incorporate feedback and make minor adjustments to their presentations (refer to Table 1). All student groups received individual and group feedback with completed rubrics documents from their instructors at the end of the semester.

Table 1. Weekly schedule for the course.

Weeks of the Semester	Activity
Week 0	Start of Semester: Individual and group assessments available to all students.
Week 1 to 6	Students attend six three-hour synchronous seminar sessions.
Week 1 to 2	Students to form groups of four and select their industry/local organisation for proposal formulation.
Week 3	Students submit an individual assignment (related to the group assignment).
Week 5	Students receive feedback on individual written assignment.
Week 7	Break
Week 8 (Session 1) and 9 (Session 2)	Presentations are scheduled over two weeks due to large class size. Each group has 20 minutes for their presentation and 10 minutes for a Q&A session within a 3-hour slot. Non-presenting groups may attend peer presentations. All students had access to the recordings.
Week 10	Groups to submit final presentation. Groups are allowed to make minor edits to the presentation slides based on feedback but no content changes were allowed. Session 1 groups have an additional week for these edits to ensure more fairness as Session 2 groups have access to Session 1 presentations.
Week 12	Groups to receive completed rubrics documents with individual and group feedback. End of Course/Revision Week
Weeks 13 to 14	Written exams

Data collection and analysis

To evaluate the effectiveness of synchronous group presentations, mixed-method surveys targeting both students and instructors were employed. The survey questions were guided by the Community of Inquiry framework to assess the planning and delivery aspects of synchronous presentations. Qualitative questions specifically addressed initial concerns, adopted strategies, and future recommendations related to the synchronous group presentation format.

After obtaining Institutional Review Board (IRB) approval, the survey was distributed later than planned (Week 13), resulting in a lower response rate due to some part-time learners not checking their institutional emails post-course. A total of 28 student responses (19 part-time learners and 9 full-time learners) and six instructor responses were received.

Thematic analysis was applied to identify common themes related to the effectiveness of synchronous group presentations, student engagement, challenges and strategies (Braun & Clarke, 2006). Additionally, ChatGPT-4 assisted in identifying potential missed themes, ensuring a comprehensive analysis. The emergent themes were aligned with the Community of Inquiry and Authentic Assessment Framework. Detailed descriptions of these themes for both students and instructors are provided in the next section.

Based on the findings, recommendations were proposed to refine the assessment strategy, emphasising human elements and reducing reliance on GenAI tools (Liu et al., 2023).

Findings

Quantitative analysis of students' and instructors' responses

Quantitative survey responses indicated a positive reception towards synchronous group presentations among instructors, part-time and full-time students.

Table 2 presents student-reported impact of synchronous group presentations compared to written assignments. A significant 82% of students agreed or strongly agreed that this format promoted collaboration and interaction, and similarly, 79% felt it fostered discussions on course concepts. 71% noted that preparing for synchronous group presentations required comprehensive reviews of group contributions, enhancing engagement with the material. Positive impacts were also noted in understanding of course content as 72% of the students felt that the presentations had positively influenced their understanding of course content. 82% of the students felt that the presentations improved their confidence in presenting ideas.

Table 2. Student perspectives comparing synchronous group presentations with written assignments.

Compared to written group assignments, synchronous group presentations…	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Promoted more collaboration (frequent and meaningful interactions)	36%	46%	18%	0%	0%
Required more frequent negotiation and discussion of course concepts	43%	36%	18%	4%	0%
Required review of each group member's contributions in more detail	39%	32%	21%	4%	4%
Positively influenced my understanding of course content	29%	43%	21%	7%	0%
Improved my ability to present ideas coherently and confidently	29%	53%	18%	0%	0%

Based on instructors' quantitative responses (presented in Table 3), the majority observed that synchronous presentations significantly boosted student interactions and facilitated deeper discussions on course concepts, enhancing the social presence in the online setting. Opinions varied on whether these presentations led to a more thorough review of peers' contributions. While some instructors noted an increase in content engagement and comprehension, others reported neutral experiences, suggesting variability in student engagement levels.

Qualitative analysis of students' and instructors' responses

Through qualitative analysis of the responses from students and instructors, a number of themes emerged. Table 4 describes the students' responses based on themes that relate to the COI components and the AAF dimensions. Table 5 describes the instructors' responses based on themes also related to COI and AAF. From the two tables, it was clear that both instructors and students had similar concerns in

Table 3. Instructor perspectives comparing synchronous group presentations with written group assignments.

Compared to written group assessments, synchronous group presentations…	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Required students to interact more frequently and meaningfully with group members	50%	33%	0%	17%	0%
Required students to negotiate and discuss course concepts with group members more frequently	17%	67%	0%	17%	0%
Required students to review each group member's contributions in more detail	17%	33%	33%	17%	0%
Positively influenced students' understanding of course content	17%	33%	50%	0%	0%
Improved students' ability to present ideas coherently and confidently	50%	33%	0%	17%	0%

areas such as content application, skill development, peer collaboration and instructional design. More in-depth analysis was done to better understand the challenges faced by the students and how they mitigated these challenges. The rest of this section describes the challenges and concerns faced by students and instructors, as well as findings related to skill development and the use of GenAI.

Table 4. Themes aligned to the COI and AAF Frameworks for students' qualitative responses.

COI Component	AAF Dimension	Theme	Definition	Sample Quotes
Cognitive Presence	Task	Content Application Concerns	Students' concerns about applying course concepts effectively during real-time presentations	"Applying the concept to the scenario given and ensuring my teammates are able to do the same." "I think while group presentations is more difficult for me, I felt that I have actually learnt more about the said topic and I tend to understand and remember the concepts covered more effectively."
	Task	Content Delivery Strategies	Methods used by students to improve presentation and delivery, such as frequent reviews and rehearsals	"We assisted one another and reviewed our scripts to ensure it was coherent and transitioned smoothly." "Constant review of slides (biweekly) and ensuring that the content answers the questions/key points of the scenario." "We had dry runs to ensure that we did not exceed the time and also to synchronize between the presenter and the slide controller."
	Task	Skill Development	Development of essential skills such as communication, presentation, and confidence building	"Presentation as it boosted my confidence." "The combination of understanding the topic and presenting it in a coherent and understanding way is a very important skill for work." "Group presentation because it improves communication and presentation skills which many students lack."
	Task and Assessment Result	Realistic Assessment	The extent to which group presentations reflect real-	"Group presentation because its more realistic and we can practice our presentation skills."
			world scenarios and professional practices	"Group presentations as we need to present ideas in the workplace."
	Physical Context	Time Management	Responsibilities and managing deadlines in real-world context	"Difficulty to find a common time to plan and discuss on how to tackle the [assignment] questions." "We had to meticulously arrange and plan our schedules to ensure we all were free to practice and collaborate."
	Social Context	Presentation Anxiety	Presentation anxiety and uncertainty of questions clients may ask reflects real-world context	"Fear of face-to-face presentation." "My initial concern was on the uncertainty of questions that may be asked."
Social Presence	Social Context	Peer Collaboration	Significance of working with peers and the benefits and challenges associated with it	"Concerns about members not participating and contributing appropriately."
	Social Context	Group Dynamics	Challenges faced in coordinating group work, including non-participation and scheduling conflicts	"Some members did not contribute to the ppt / word document that was used to share our ideas." "Getting reliable groupmates is a challenge."
Teaching Presence	Social Context	Instructor Guidance	Role and importance of instructor support in providing feedback, guiding and mediating conflicts	"Report to course coordinator, did weekly meetups and updated to ensure team is progressing." "Instructor was able to advise …."
	Assessment Criteria	Instructional Design	Rubrics and guidelines	"We clarified with our instructor about the content expected." "I found out that different instructors had different guidelines and specifications about the synchronous group presentations."

Students' challenges and mitigation strategies

Challenges of group work

Students expressed several concerns typical of group work, particularly in an online setting —equitable participation, group composition, and the impact on individual grades were predominant issues. One student highlighted the risk

Table 5. Themes aligned to the COI and AAF frameworks for instructors' qualitative responses.

COI Component	AAF Dimension	Theme	Definition	Sample Quotes
Cognitive Presence	Task	Content Application	Students' ability to apply course concepts	"Some groups did not focus and address the [questions] well."
	Task	Skill Development	Development of students' skills, such as presentation and critical thinking skills	"Students' presentation skills significantly improved." "The Q&A sessions fostered deeper critical thinking." "Slides are usually bullet points…limited time to present...not sure about depth of their understanding …quality of individual presentation skills" (initial concern)"
	Task	Realistic Assessment	Evaluation methods that reflect real-world applications and challenges.	"The questions need to be well-drafted and be application-oriented."
	Assessment result/Form	Plagiarism	The decrease in instances of plagiarism and use of AI-generated content	"Live presentations minimized the chances of plagiarism." "This format provides a more authentic assessment of student abilities."
Social Presence	Social Context	Peer Collaboration	Role of working with peers in learning processes and achieving course outcomes	"(concerns about) the quality of student collaboration."
	Social Context	Group Dynamics	Handling interpersonal relations and team roles within group projects.	"Management of group dynamics was crucial for the synchronous presentations…."
Teaching Presence	Criteria	Instructor Guidance	Strategies to support content application and skill development	"I shared additional short segments of how to present better with my students."
	Criteria	Instructional Design	Guidelines and standards used to evaluate student performance and learning	"The Scoring Rubrics has been well-thought out." "The live format allowed for instant feedback and clarifications." "Tweak the weightages of the different categories to reflect greater importance of the: Individual's contribution to … In particular, the Individual's knowledge of the right content as well as their presentation skills to achieve the goal of the [assignment]"

that non-contributing members "*will jeopardise the rest of the team*." Another student shared about "*concerns about members not participating and contributing appropriately.*" Questions about the impact of a peer's lack of engagement on individual grades were also raised, for example, "*How would the individual [peer's] presentation affect my marks?*" Additional concerns included the application of course concepts, presentation anxiety, technical difficulties, and the unpredictability of questions during Q&A segments.

A significant challenge was coordinating schedules, especially for part-time students balancing work and study commitments. One student noted, "*As a part-time student, it takes a lot more of my time that I already don't have.*" Another explained the difficulty of aligning group availability due to diverse academic schedules:

> "our group came from different courses and also taking different modules, the greatest challenge was finding a common time…. A lot of adjustment needed and perhaps even personal time sacrifices in order to accommodate the common time."

One student explained:

> "The alignment of schedules, especially with a mix of part-time and full-time students and overseas work travel… the group was willing to make sacrifices, holding online meetings at odd times like 6am and 10pm."

Another student contrasted the dynamics of online versus face-to-face classes:

> "In face-to-face classes, at least we meet once a week, but we can't discuss our assignment during Zoom… we have to conduct separate sessions."

Students adopted various strategies to mitigate the challenges of synchronous group work, focusing on task management, communication, technological facilitation and seeking instructor support. Early task division, regular reviews, and rehearsals were key to ensuring smooth transitions between presenters. Preparation for potential technical issues included conducting dry runs and ensuring multiple members had access to presentation slides, with cues like "next slide" to maintain flow during handovers between presenters. One student described their approach:

> "We assisted one another and reviewed our scripts to ensure it was coherent and transitioned smoothly."

Another highlighted the importance of accountability in managing tasks:

> "The group assigned tasks to individual members and held each other accountable by having regular online meetings."

As online students who did not meet regularly, students used technology to facilitate collaboration. Popular platforms such as Zoom, Telegram, WhatsApp groups and Google Docs were instrumental for sharing documents and presentation materials. A student shared, "*We try to use Zoom, Telegram, and Google Docs to share the workload.*" Another student said, "(It started with) creating a WhatsApp group".

The above strategies aligned with the physical and social contexts of the AAF to address real-world challenges like limited resources and the need for positive interdependence and individual accountability in group work.

Sources of support

From students' qualitative responses, it was noted that instructors played a pivotal role in supporting students and reaching out to non-participative members. To address non-participation, students reported issues to course instructors, stating, "*…when we are unable to contact the specific member, we email the professor for help.*" Another added, "*Report to course coordinator and updated to ensure the team is progressing*."

It was evident that students had used multiple sources of support. Interactions with group members and course materials, such as rubrics and study guides, were identified as the most beneficial. Instructor guidance and class activities were generally seen as beneficial. External resources and AI tools like ChatGPT were considered slightly less useful than other aspects.

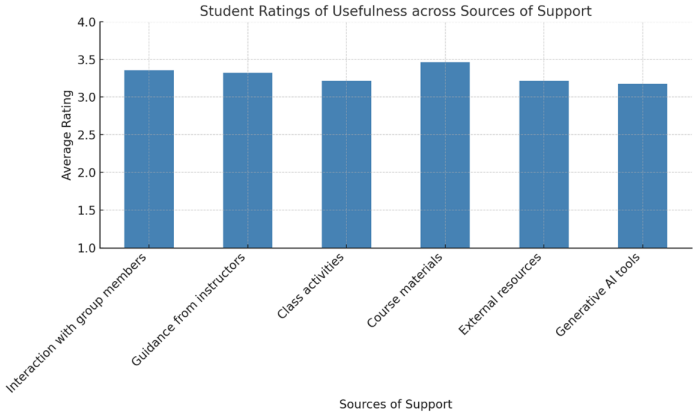

Figure 1. Student ratings of usefulness across sources of support.

These findings aligned well with the COI framework. The improvement in students' ability to present ideas confidently indicated a heightened cognitive presence, as students were required to engage deeply with the content and articulate their understanding effectively. The increased collaboration and interaction among group members reflected a strong social presence, fostering a supportive and interactive learning environment. Additionally, the structured guidance, managing group dynamics and resource provision exemplified teaching presence.

Instructors' concerns and mitigation strategies

Concerns about group work

Instructors voiced specific concerns about student participation and equitable contributions for the group presentations. They were worried about the risk of free-riders and potential disputes over workload distribution, encapsulated in concerns such as, "*whether they would speak up and contribute,*" and "*Initial concerns were on proof-of-work in terms of each person's contribution and workload.*" Instructors were also concerned about the groups' preparation for the presentations.

Instructors implemented various strategies to mitigate concerns. They provided additional guidance, posted reminders, and offered resources to develop presentation skills. This included conducting in-class briefings to familiarise students with presentation requirements and expectations. For instance, one instructor added, "*additional short segments on how to present better*," while another "*encouraged active participation during weekly classes to refine students' presentation skills and provide feedback*". Instructors adopted proactive communications strategies and kept students informed about potential technical issues and outlined contingency plans through in-class discussions and supplementary instructions.

Consistent with other studies, the dynamics of group work sometimes led to a cooperative rather than a truly collaborative effort (Donelan & Kear, 2023). An instructor observed,

> "Students … signed in separately to do their own part… this is no difference from what they did in the past [which is a] written report … each group member [is] only responsible for his/her part, resulting in incoherence."

The assessment rubrics were designed to penalise such disjointed efforts. The instructor's immediate feedback and post-assessment feedback for individual and group components would have included the lack of collaboration in the group work.

Challenges during presentations

During the presentations, instructors encountered several challenges that impacted student engagement and the overall effectiveness of the sessions. Other concerns include maintaining the quality of interaction during the presentation sessions.

A significant challenge was the hesitancy of students in the audience to engage during the Q&A segments. One instructor noted, "*Students (audience) were hesitant to ask questions, rendering the Q&A somewhat redundant.*" This lack of engagement limited the interactive potential of the presentations.

Instructors also faced difficulties in fully grasping the students' thought processes and solutions during the presentations as students were not required to submit their presentation slides before their presentation. One instructor commented:

> "Due to the lack of pre-provided materials (presentation slides), it was sometimes challenging to follow the presentation and grasp students' thought processes."

To improve this, another instructor suggested, "*Requiring students to submit their … PPT three days before the presentation would enhance understanding.*"

Two instructors went a step further by requiring students to submit visual aids in advance (even though it was not required) to ensure that the Q&A session would be more targeted. One instructor explained:

> "I made students hand in their visual aids (via email) before the presentation even though submission deadline was after the presentation and emphasised that they need not show the visual aids during presentation. This is so that they won't use the share screen on zoom, which result in seeing only a very small screen of the presenter."

Although this strategy supported concerns about assessing non-verbal cues and managing Q&A sessions, it might pose a problem for students observing the presentation as students would not be able to view the slides during the presentation. While the two instructors showed initiative in adding this requirement for students, it raised issues of inconsistent guidelines and practices between classes.

Initial concerns about potential technical glitches were prevalent among instructors. However, based on the feedback, presentations proceeded without technical issues, suggesting a general network stability and both instructors' and students' familiarity with synchronous video platforms.

Promoting professional skill development and content mastery

Despite the initial concerns, more than 80% of students would recommend synchronous group presentations over traditional written assignments, citing significant benefits in communication and presentation skills development. One student commented:

> "Presentations are pretty common in my future working industry… a good opportunity for me to build this soft skill so that my competency gets better."

Other comments from students included:

> "… builds my confidence in public speaking and sharing of knowledge."

> "… it's more realistic and we can practise our presentation skills."

> "… as we need to present ideas in the workplace."

Students noted deeper learning through this format:

> "While group presentations are more difficult for me, I felt that I actually learned more about the topic."

Another student summarised:

> "I find that I learn more through group presentations as I need to understand everything to check my group mates' work and to be able to answer any questions posed."

The active engagement required in presentations — such as brainstorming and dispute resolution — was seen as particularly beneficial:

> "The exercise of presentation, communication, brainstorming, and dispute-solving skills at the workplace reinforces concepts as we're required to verbalise our thoughts."

The value of instructor feedback and the development of transferable skills was also highlighted:

> "…After the course, I had to do a (another) video presentation. I think what the lecturer told and guided us on was very helpful…"

Instructors also acknowledged that synchronous group presentations generally improved students' confidence in presenting ideas and increased engagement. One instructor observed,

> "… they enjoyed the learning ... They even went to the [extent] of role-play as [agency] staff with the full works of [agency] logos on their [presentation]..."

However, one instructor noted that some students appeared to be reading off scripts, which might undermine the authenticity of the presentations. Nevertheless, all six instructors endorsed the use of synchronous group presentations, though they suggested incorporating additional guidelines to enhance their effectiveness.

Leveraging human skills in the age of generative AI

Students reported usefulness of external resources and AI tools like ChatGPT (Figure 1). However, AI was considered somewhat less useful than other aspects. Part-time students reported slightly higher utility of AI tools, possibly reflecting greater professional integration of such tools.

Instructors' responses focused on assessment tasks that would reduce the unethical use of GenAI tools. Examples include "*This format provides a more authentic assessment of student abilities*" and "*Live presentations minimised the chances of plagiarism*". Another instructor commented that the use of synchronous presentation "*minimises risk of irresponsible use of generative AI tools. This is because students would need to consider how they can convey their ideas across in a speech*".

One instructor pointed out that the rubrics criteria ensured students who relied solely on AI for creating presentation content would be at a disadvantage:

> "Of course they could use generative AI tools to help them …., but…. how they made the presentation effective in the way they spoke as well as the team dynamics. ….end up the wrong approach, hence still fare badly"

An instructor summarised the evolving challenges of detecting plagiarism with traditional tools like Turnitin, especially with the advent of ChatGPT4, suggesting the need to redesign assessments:

> ".. written report on ChatGPT4 is a breeze, and Turn-it-in (Turnitin) could no longer detect plagiarism. If it is going to be an assistive tool, then let's work with it and switch mode to synchronous group presentations as a pedagogy moving forward. … applicable …for a digitally native world of AI and the usage of Large Language Models."

Only one instructor took an opposing view, suggesting the need for an additional written report to enhance the detection of possible plagiarism and demonstrate deeper understanding. The instructor explained:

> "For slides and presentations, the Turnitin check is not available (I believe). If students submit a (written) report in conjunction with doing presentations, we would be able to assess the Turnitin percentage and details. During the presentation, students can be asked more specific questions to assess their knowledge and understanding and how they derive the content of their presentations."

Discussion and recommendations

Discussion

The aim of this research is to explore the potential of using synchronous group presentations to create opportunities for students to develop communication and presentations skills and address the GenAI-related challenges in higher education assessment brought about by GenAI. Through a pilot study conducted in an online course with part-time, adult learners, we could see that synchronous group presentations were effective as an authentic assessment, and it had the potential of mitigating the challenges from the emergence of GenAI.

This research gave us a rich understanding of how students perceived synchronous group presentations compared to written assignments. Students highlighted the necessity for deeper engagement with content, as they were required to apply, discuss, and defend their ideas in real-time, reflecting increased cognitive presence. The requirement for live interaction, negotiation, and collaborative problem-solving in group presentations directly engaged with the COI and the AAF emphasis on the social dimensions of learning. These interactions ensured that the assessment could not

be completed by solely relying on GenAI. Students reported that the assessment mirrored professional real-world activities, enhancing the authenticity by addressing the physical and social contexts of the tasks.

While students' perception was generally positive, they also shared a number of challenges that they faced as adult learners in an online course. Some of the issues faced by students were consistent with findings from previous research on the dynamics of both virtual and in-person group work (Jung et al., 2023; Roberts & McInnerney, 2007). Through this research, we saw how students came up with different strategies to mitigate the challenges that they faced. We also saw that instructors were positive about the use of synchronous group presentations. Although there were issues in implementing this solution, different instructors came up with various ways to mitigate the issues.

One of the concerns from instructors was plagiarism detection. Instructors were concerned that presentation slides, unlike written assessments, cannot be directly scrutinised by text-similarity software such as Turnitin. The effectiveness of plagiarism detection software is increasingly questioned, particularly with the advancement of generative AI tools. Several authors have highlighted the limitations of these tools as AI technology evolves, become more ubiquitous and students become adept at navigating such systems (Liu et al., 2023; Rudolph et al., 2023; Topinka, 2024). These findings underscore the importance of continuous education and awareness among instructors about the latest technological developments to ensure that assessment methods remain robust and effective.

Overall, instructors and students favoured synchronous group presentations for their ability to provide a more authentic assessment experience, promote engagement, and develop essential skills. However, they also highlighted the need for additional support mechanisms and fair assessment practices to ensure equitable participation and mitigate challenges.

Based on the identified themes, it was noted that metacognition and self-evaluation were not prominent in this case study. According to Ashford-Rowe et al. (2013), developing students' metacognitive abilities through self-assessment and critical reflection was a crucial component of authentic assessment tasks. While this study's approach of making assessment criteria transparent helped students align their work with expected standards, thereby aiding in effective planning and potentially fostering self-reflection, Villarroel et al. (2018) pointed out that merely publishing criteria had its limitations. Addressing this limitation in future iterations of the assessment design will further enhance the authenticity of the assessment.

Recommendations

Practical implications and insights were gleaned from this research, which we present as recommendations for institutions and instructors who would like to implement synchronous group presentations as an authentic assessment:

1. Developing presentation skills and student interaction in a systematic manner

Most instructors had incorporated opportunities for students to practise presentation skills during weekly in-class presentations, providing students the opportunity to receive formative feedback. Instructors also provided additional external resources and guides. Several instructors recommended including short segments on presentation design and presentation skills in the course curriculum. This would help students to improve their presentation skills.

Some students noted the difficulties in meeting up with peers in the online environment as compared to opportunities during face-to-face classes. As interaction with group members are viewed as the most useful aspect to support the task, instructors will need to foster a social presence that mirrors the informal interactions of face-to-face settings, albeit digitally, pre or post class to facilitate more interaction opportunities for groups. Previous studies have reported such instructor immediacy strategies facilitate meaningful learning for online groups (see Melrose & Bergeron, 2007).

To ensure the questions asked during the Q&A segments are thoughtful and enhance critical thinking, each group could be assigned to review a specific peer group's presentation in advance and prepare relevant questions. This strategy not only promotes deeper engagement but also encourages active participation and critical analysis among students.

2. Enhancing fairness across large cohorts

Addressing fairness across large cohorts emerged as a critical concern due to discrepancies in how presentations were managed across different groups, leading to uneven experiences. Instructors and students raised concerns about the timing of presentations and the possible privilege to groups which were presenting in a later session. As how one student pointed out:

> "...groups presenting later can take advantage of more preparation time and preview the presentations done by the earlier groups. They are more likely to score a higher grade. This damages fairness and justice."

To prevent later-presenting groups from potentially gaining an unfair advantage by viewing earlier sessions, restricting access to presentations and recordings of the first session was proposed. "*Session 2 Group Presenters should not be allowed to attend or access the Session 1 recording*". However, this would compromise peer learning as students would not be able to learn from all presentations. A better way would be to consider how all presentations could be scheduled on the same day.

Students also raised concerns that different instructors had different guidelines and specifications concerning the submission of presentation slides, suggesting the need for consistent guidelines and standardisation across classes. Some classes were asked to submit their presentation slides in advance, but this was not consistent across all classes. There was a strong recommendation from instructors on

the standardisation of submission practices, specifically requiring the advance submission of presentation materials. This would allow instructors to review content beforehand, and address students concerns by ensuring a more equitable and coherent assessment process.

Instructors had already implemented strategies such as pro-active communication, technical readiness briefings, additional resources and seminar activities to provide feedback on presentation skills. As suggested by one instructor, these practices should be further refined and uniformly applied in the seminar plans for all tutorial groups.

3. Promoting individual accountability and positive interdependence

Non-responsive group members and lack of participation are well-documented issues in collaborative learning environments. An instructor suggested that scoring rubrics could be refined to increase the emphasis on individual contributions relative to teamwork. Another instructor had remarked that some students "*signed in separately to do their own part*". This adjustment might further encourage a focus on personal performance, potentially at the expense of collaborative skills and positive interdependence.

Strengthening teaching presence through clearly communicated requirements, along with peer and self-evaluations, has been suggested as effective strategies to mitigate these group work issues (Donelan & Kear, 2023). Moving forward, administering peer and self-evaluation forms could enhance individual accountability and improve group dynamics. This would also address the need for metacognition to deepen learning.

4. Integrating GenAI tools to develop AI literacy

At the institutional level, students were permitted to use AI tools (where explicitly stated) to support the assessment process, with the necessary acknowledgements. With the increasing ubiquity of generative AI in educational settings, it is argued that its use is becoming "inescapable" (Lui et al., 2023; Rudolph et al., 2023). Therefore, we suggest that authentic assessments tasks that simulate real-world scenarios should incorporate the use of AI tools. Lodge et al. (2023) recommended that assessment designs, where both AI and students contribute to products like presentations, should provide clear opportunities for students to critically engage with AI, use it judiciously, and reflect on their learning.

Rubrics for synchronous group presentations could actively promote the development of AI literacy skills. Future iterations should require students to use AI tools ethically and productively. The Q&A segments could incorporate discussions on AI usage and reflection on the learning process. To ensure equitable access, introducing students to the Presenter Coach AI feature in Microsoft PowerPoint (available to all students) to enhance presentation proficiency could be beneficial (Microsoft, 2021). Additionally guiding students to use freemium or limited free AI tools that aid in the design and development of presentations, such as Gamma.Ai can help develop skills to use AI productively (see Wells, 2024 for further suggestions).

Instructors' insights reinforce the importance of synchronous group presentations in enhancing cognitive and social presence, supported by effective teaching strategies, to promote authentic learning. In the age of advanced AI, these assessments emphasise the critical human elements of collaboration and critical thinking, as noted in recent research (Liu et al., 2023). It is evident that there is a need to plan more strategically and deliberately for the development of essential skills and the ability to leverage AI to enhance productivity.

5. Blending asynchronous presentations with synchronous Q&A

Students' suggestions for improvement included offering both synchronous and recorded asynchronous options to enhance flexibility. A possible solution is a combination of recorded presentations (for instructors and students to view before the session) with a 15-minute Q&A segment during a scheduled synchronous session to provide meaningful real-time interactions. This format will allow students to prepare and record their presentations at their own convenience, effectively addressing the diverse scheduling needs of adult learners (Lowenthal & Moore, 2020). To ensure authentic engagement and facilitate peer-to-peer learning, these recorded presentations would be made available on a common platform, such as the Learning Management System, allowing all students to view the presentations before the synchronous session.

During the real-time Q&A, students will have the opportunity to demonstrate their depth of understanding by actively defending their views in front of a live audience and demonstrate their ability to navigate online social contexts. This approach also addresses instructors' suggestions to review the presentations in advance. The Q&A can be focused on in-depth questions that challenge students' comprehension and application of the material. Questions that specifically probe students on their use of AI tools and their reflections on the process will promote the development of AI literacy. Additionally, online peer evaluations will be administered upon submission to address participation issues and increase individual accountability.

To maintain fairness and prevent any group from gaining an undue advantage due to their presentation order, the shorter synchronous segment for each group will facilitate assessing all groups equitably within the same session. To enable more focused Q&A sessions, groups can be placed in a Zoom waiting room and admitted based on presentation slot.

This revised strategy aims to blend the flexibility of asynchronous presentations with the immediacy of synchronous evaluations, creating a more comprehensive and fair assessment process that effectively prepares students for professional realities.

Limitations and future research

Limited sample size, characteristic of many pilot studies, and the student demographics pose challenges in generalising the findings across broader online educational settings. While the rich insights gained are invaluable for understanding specific dynamics within this cohort, future studies should aim to include a more diverse and larger sample to further investigate across various demographics and learning environments.

This study underscores the importance of adopting flexible assessment strategies that leverage human skills and GenAI tools to enhance student learning outcomes. However, it offers limited insights on how AI tools were used to support students learning. As AI continues to advance, our educational approaches must also evolve to fully harness its potential while enriching the learning experience. Future research should focus on exploring how different types of AI tools can be ethically and effectively leveraged for synchronous group presentations whilst ensuring the achievement of learning outcomes.

Conclusion

This study explored the application of synchronous group presentations within a specific educational context. Both instructors and students have underscored the value of synchronous group presentations in fostering an authentic, interactive, and engaging assessment experience. The insights and recommendations offered here can provide valuable guidance for educators and institutions aiming to improve learning outcomes in online courses for adult learners in the age of generative AI.

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Investigating students' perspectives on the integration of generative artificial intelligence in university curricula and assessments

Evelyn Hui Ting Gay[A] [A] *Senior Lecturer - Teaching & Learning Centre, Singapore University of Social Sciences*

Gabriel Charles Gervais[B] [B] *Director, Online Learning, Singapore University of Social Sciences*

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Correspondence

evelyngayht@suss.edu.sg [A]

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Abstract

The incorporation of Generative Artificial Intelligence (GenAI) in education offers new opportunities to enhance students' learning experiences. Using a Chi-square Automatic Interaction Detection (CHAID) analysis, this study examined how the frequency of GenAI use for higher-order learning tasks and for supporting learning, as well as various demographic factors, influence students' attitudes towards GenAI.

The first decision tree analysis revealed that the respondents' GenAI usage frequency for higher-order learning was the most important factor determining their desire to see GenAI incorporated into the university's curriculum and assessment. In addition, for some learners, the study found that age was a significant factor, with the younger learners having a more positive attitude towards this technology than those who were older. An analysis of the second decision tree found that the frequency of GenAI use for learning support was the most important determinant of the students' willingness to have GenAI mark their assignments. An understanding of how demographic and contextual factors influence the students' attitudes towards the role of GenAI in education can guide academic institutions and educators in the development of effective educational strategies and policies that facilitate its acceptance by a diverse student population.

Introduction

Since its inception in 1956, the term "artificial intelligence" (AI) has surged in popularity and today, thanks to the recent development of very promising real-world applications (Górriz et al., 2020), few doubt the potential that this technology has to transform all domains of human activities (SAS, n.d.). Generative Artificial Intelligence (GenAI) applications have also garnered widespread interest in education, where it has triggered some of the most profound transformations the field has ever experienced (Dwivedi et al., 2023).

As GenAI technologies evolve and become more common, they offer new opportunities for educators to enhance their students' learning experiences and performance assessment. It is, therefore, timely to explore how the very individuals who interact with GenAI on a daily basis, in the case of this study, tertiary students, perceive the implications of the incorporation of GenAI tools into their programme curriculum and assessment.

Previous studies have shown that the effective use of technology depends on various factors, including the frequency and context of use, as well as the demographic characteristics of the users, such as their age and gender (Draxler et al., 2023; Morris & Venkatesh, 2000; Robinson et al., 2015; Stöhr et al., 2024; Venkatesh & Morris, 2000). However, as the specific drivers of the students' desire for GenAI incorporation into curriculum and assessment remain underexplored, they warrant further investigation.

This study used the Chi-square Automatic Interaction Detection (CHAID) analysis to identify and understand the key factors influencing students' desire to incorporate GenAI into their university curriculum and assessment. By examining how different demographic and contextual factors affect these students' preferences, this study aimed to provide timely insights that inform the development of educational strategies and policies that align with students' needs, providing actionable insights for educators, researchers, and policymakers. These insights are crucial as they ensure that the GenAI-enhanced teaching and assessment practices that are designed and implemented take students' perspectives into account.

This research is guided by a conceptual framework that examines how the frequency of GenAI use for higher-order learning tasks and for supporting learning influences students' enthusiasm for GenAI integration. The framework also considers the role of demographic and educational factors, including age, gender, race, and year of study, in shaping students' attitudes towards GenAI.

The following sections successively present the literature review, outline the research methodology, present the results of our analysis, and discuss the implications of our findings for educators, researchers and policymakers.

Literature review

In today's world of fast-paced technological changes, GenAI represents one of the most formidable forces that have revolutionised how individuals work and interact with the world around them (Bahroun et al., 2023). Among the many domains of human activity, education stands out as one where GenAI is showing the most significant impact (Dwivedi et al., 2023) as evidenced by recent studies that have examined the potential of GenAI to enhance learning outcomes and transform traditional educational practices (Ali et al., 2024; Bahroun et al., 2023; Bower et al., 2024; Kim et al., 2022).

This literature review synthesises the existing research on GenAI in education, focusing on its role and use in teaching, curriculum development and assessments as well as how students perceive and use it for learning.

Some AI tools can be used to support educators in assessment tasks by generating assessment questions, automating student essay marking and grading, assessing learning processes, and developing personalised assessments (Swiecki et al., 2022). Other AI tools may also enhance the ability of educators to focus on process-oriented assessment, which seeks to understand the process students go through when completing a learning task, rather than just evaluating the final result (Kim et al., 2022). In addition, GenAI tools can be used in course development, more specifically, for tasks such as generating course outlines, lesson plans, learning objectives, identifying topics, curating learning resources, facilitating personalised learning, and designing learning activities (Hadi et al., 2023).

The increasing adoption of GenAI in education also has an impact on teaching practices. AI can be utilised in the curriculum to foster higher-order thinking skills such as problem-solving and creativity (Kim et al., 2022). Educational institutions can enhance learning by integrating AI within the curriculum and providing opportunities for students to develop key areas of AI literacy, regardless of the students' academic field of study (Southworth et al., 2023). In addition, it is important to teach students the responsible use of GenAI, including critically assessing the quality and accuracy of its outputs (Bower et al., 2024).

Because GenAI is relatively new, the research literature on its role in education is still nascent. Existing studies that primarily focused on the applications of GenAI in education highlighted its benefits, the ethical challenges and inaccuracy issues it raises, and the deleterious effect it has on students' critical thinking (Ali et al., 2024; Zhu et al., 2023). Some researchers (e.g., Bahroun et al., 2023) have proposed that future research should seek to better understand the use of GenAI in education, particularly on the acceptance and adoption of GenAI by students, focusing on understanding the factors that shape their attitudes towards it as well as on the strategies that can positively influence their acceptance of such technology (Bahroun et al., 2023). Although a few studies have examined student perceptions of GenAI (Baidoo-Anu et al., 2024; Chan & Hu, 2023; Johnston et al., 2024), further research is needed to explore factors that influence students' attitudes towards

the integration of GenAI into the programme curricula and assessments, a gap that this research aims to fill.

Prior research shows that demographic factors, including age and gender, do affect technology usage and attitudes towards technology (Draxler et al., 2023; Morris & Venkatesh, 2000; Robinson et al., 2015; Venkatesh & Morris, 2000). A study conducted by Draxler et al. (2023) found that among a sample of US citizens, females were less likely to use GenAI than their male counterparts and that younger users were more likely to use GenAI than older ones. In addition, the study found that the effect of gender is most pronounced among young adults, while it becomes only marginal for users from older age groups. However, the role of gender and other demographic factors requires further investigation in the context of GenAI within the education context. More generally, an understanding of the demographic patterns in the use of GenAI in education can guide academic institutions and educators in the development and implementation of effective policies that facilitate its acceptance by a diverse student population.

The frequency with which students use GenAI tools for learning influences their attitudes towards GenAI. Stöhr et al. (2024) found a strong positive correlation between familiarity with ChatGPT and favourability of attitude towards such tools. Individuals who are more familiar with these tools tend to perceive greater benefits from their use. However, it is not immediately clear that frequency of usage of GenAI tools in various contexts influences students' attitudes towards incorporation of such tools into curriculum and assessment. Even if students frequently use GenAI tools, they might question the appropriateness of integrating these tools into educational assessments or curricula. Students might have reservations about using GenAI because of their concerns about academic integrity, reliability and potential biases relating to its outputs.

While the potential benefits of the use of GenAI in higher education are evident, the literature reveals a gap in understanding the specific factors that influence students' desire for the incorporation of such tools in curricula and assessments. This study aims to fill this gap by exploring how the frequency of GenAI use across different types of learning activities, along with demographic and educational factors such as age, gender, race, and year of study, influence students' desire for the integration of GenAI in their studies. By building on the existing literature and addressing this research gap, this research seeks to provide insights that can inform institutions and policymakers tasked with developing and implementing policies and strategies that guide the integration of GenAI into university curricula and assessments.

Conceptual framework

The incorporation of GenAI into university curricula and assessments has the potential to enhance students' educational experiences (Chan & Hu, 2023). To realise this potential, it is essential to understand the factors that influence students' desire for such integration. The conceptual framework of this study (Figure 1) examines how the frequency of GenAI use for higher-order learning and frequency of GenAI use for supporting learning, as well as various demographic factors—including age, gender, race, and year of study— might affect students' desire for incorporating GenAI into the university's curriculum and assessments, and their receptivity to have GenAI mark their assignments.

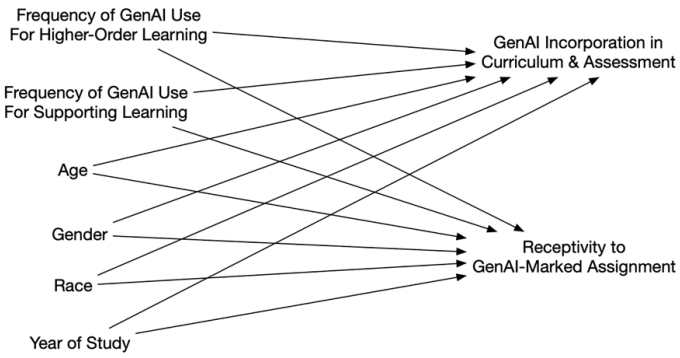

Figure 1. Conceptual framework for the study.

Methodology

Research design

This quantitative research used a survey questionnaire to gather data on the use and perceptions of GenAI among part and full-time students from a Singapore university. An analysis of the patterns and relationships found within the data led to meaningful conclusions about the students' experiences and attitudes towards GenAI.

Procedures

The recruitment of participants was conducted through various channels. Email invitations containing the survey link giving access to the online questionnaire were sent to all students. In addition, participants were recruited by posting on the university's learning management system (Canvas) invitations to participate that contained the survey link. Instructors of courses managed by the Online Learning Unit also assisted in the recruitment by making announcements to their students, inviting them to take part in the survey. Interested participants were provided with a participant information sheet containing a brief description of the study. Participants proceeded to answer the eligibility questions before the main survey. The main survey contained questions about their usage of GenAI, their perception of GenAI tools as well as demographic questions.

Participants

A total of 790 students from a university in Singapore participated in the survey. For the participants to be able to provide meaningful responses to the questions in our study, respondents needed to meet four criteria outlined in the following four screening questions:

- Are you currently enrolled in an undergraduate/ postgraduate programme at the university?
- Are you aged 18 years or above?
- Have you heard of generative AI?
- Have you ever used generative AI tools for tasks such as text generation?

Respondents who answered "no" to any of these questions were excluded from the survey. From the initial 790 participants, 85 of them discontinued the survey during the screening questions stage while 45 respondents did not meet the initial eligibility criteria laid out in the first three questions. Specifically, ten students did not meet the requirement of being enrolled in an undergraduate or postgraduate programme at the university, two did not meet the age requirement of being 18 years or older, and 33 students had not heard of GenAI. The other 660 participants responded to the question on their prior use of GenAI tools for tasks such as text generation. Among these, 531 participants (80.5%) reported prior use of GenAI, meeting the inclusion criteria. The remaining 129 participants (19.5%) indicated no prior use and were thus excluded from the study.

The first column of Table 1 presents the demographic and educational profile breakdown of all participants who met the inclusion criteria (n=531). The second column shows the demographic breakdown of the participants (n=355) who responded to the questions used as dependent variables in the decision tree analysis.

Table 1. Demographic & educational characteristics of survey participants.

Demographic & Educational Characteristics	Participants who met inclusion criteria (n = 531)	Participants included in decision tree analysis (n = 355)
Age		
18 to 24 years of age	20% (105)	29% (103)
25 to 34 years of age	24% (126)	35% (125)
>35 years of age	19% (101)	28% (98)
Missing	37% (199)	8% (29)
Gender		
Male	34% (182)	51% (181)
Female	27% (146)	40% (141)
Missing	38% (203)	9% (33)
Year of Study		
Year 1	20% (104)	29% (102)
Year 2	19% (103)	28% (100)
Year 3 and above	23% (124)	35% (123)
Missing	38% (200)	8% (30)
Race		
Chinese	45% (239)	66% (234)
Malay	10% (53)	15% (52)
Indian	3% (18)	5% (18)
Eurasian	0.4% (2)	0.6% (2)
Other	3% (15)	4% (15)
Missing	38% (204)	10% (34)

Note. Each cell in Table 1 shows both the percentage and the actual number of participants (in parentheses) that fall into each category.

From Table 1, it is apparent that the number of participants listed in the first and second columns does not show a significant difference. This can be attributed to the placement of the demographic questions towards the end of the survey. About 200 of the 531 participants who met the inclusion criteria did not reach the end of the survey, missing the demographic questions. Consequently, the number of participants in the first column who answered the demographic questions does not differ significantly from those in the second column who responded to the questions used as dependent variables in the decision tree analysis. These dependent variable questions are positioned close to the end of the survey, before the demographic section, hence, most participants who reached these questions also completed the demographic section. As a result, the number of missing responses is much smaller when the population is defined as those who answered the dependent variable questions used in the decision tree analysis.

Independent variables

Respondents were asked about their usage of GenAI in the form of the frequency with which they use GenAI tools in each of the following study contexts (on a 5-point Likert scale from 1= "Never" to 5 = "Very frequently"):

a) To complement the course material
b) As a virtual tutor or study companion to explain or clarify basic concepts, models, theories, or processes contained in the course materials
c) To summarise the course material
d) To learn more advanced or specialised topics
e) To develop my critical thinking and analysis skills
f) To translate or learn new languages
g) To get creative inspiration e.g. generate artistic or design suggestions
h) To brainstorm and generate ideas in general
i) To find references to research papers
j) To evaluate my own ideas
k) To generate partial answers to my graded assignments
l) To generate full answers to my graded assignments
m) To review and improve my writing
n) To provide feedback on my answers to graded assignments before submission
o) To generate quizzes for practice and immediate feedback
p) To generate personalised study guides
q) Other purpose – Please specify only one: _____

Other independent variables are demographic and educational factors, i.e. the respondents' age, gender, race, and year of study.

Factor analysis

Factor analysis is used to simplify data and uncover patterns within a set of variables (Child, 2006). It works by clustering variables that share common variance, thereby identifying underlying constructs (Yong & Pearce, 2013). Factor analysis was used in this study so as to easily identify and group related activities associated with GenAI usage into various larger study contexts, reducing in the process the relatively large number of variables into a smaller number of factors reflecting patterns of GenAI usage in learning processes. Grouping related behaviours into coherent factors, such as the use of GenAI for higher-order learning or for supporting learning, provides insights into the patterns of students' engagement with GenAI in their learning activities. Factor analysis enhances parsimony (Harman, 1976), facilitating the meaningful interpretation of the data.

The data were analysed using factor analysis, employing Principal Component Analysis and Varimax rotation, to identify underlying factors that represent distinct patterns of use of GenAI among students.

The Kaiser-Meyer-Olkin (KMO) test for sampling adequacy produced a coefficient of 0.927, which is greater than the benchmark of 0.5. Kaiser (1974) recommended values greater than 0.5 as barely acceptable. Values between 0.8 and 0.9 are deemed meritorious, and values of 0.9 and above are classified as marvellous (Kaiser, 1974). Additionally, Bartlett's test of sphericity is significant ($p < 0.001$). These indicate that factor analysis is appropriate, and the results can be relied upon.

Table 2 presents the factor loadings of the individual items onto the two factors identified from the data.

Table 2. Factor analysis results.

	Frequency of GenAI Use for Higher-order Learning	Frequency of GenAI Use for Supporting Learning
To complement course material	**0.814**	0.225
To act as a virtual tutor/study companion	**0.798**	0.197
To learn more advanced/specialised topics	**0.780**	0.242
To develop critical thinking & analysis skills	**0.749**	0.278
To brainstorm/generate ideas	**0.733**	0.176
To evaluate ideas	**0.695**	0.388
To review & improve writing	**0.674**	0.379
To summarise course material	**0.665**	0.367
To get creative inspiration	**0.494**	0.367
To generate quizzes for practice & feedback	0.148	**0.835**
To generate personalised study guides	0.249	**0.801**
To generate full answers to assignments	0.168	**0.739**
To provide feedback on answers to assignments	0.449	**0.616**
To translate/learn new languages	0.279	**0.570**
To generate partial answers to assignments	0.467	**0.568**
To find references to research papers	0.369	**0.544**
% of Variance	33.591%	25.175%
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.927	
Bartlett's Test of Sphericity		
Approx. Chi-Square	4051.457	
Df	120	
Sig.	.000	

Note: The numbers in the table indicate factor loadings, with the major ones shown in bold.

A total of two factors were identified. The first factor explains 33.591% of the variance in the data after rotation, and the cumulative variance explained by the two factors is 58.766%. The literature recognises that there are generally two qualitatively different approaches to learning - the surface and the deep approaches (Aharony, 2006; Biggs, 2003; Dinsmore & Alexander, 2012). As defined by Baeten et al. (2008), the "deep approach to learning is associated with student intention to understand and to distil meaning from the content to be learned", whereas the surface approach to learning "is characterised by a student's intention to cope with course requirements" (pp. 359–360).

As shown in the factor analysis results (see Table 2), the nature of the nine items loaded onto the first factor suggests that the first factor can be labelled as "Frequency of Using GenAI for Higher-Order Learning". The activities associated with this factor involve the use of GenAI in ways that actively engage students in their learning processes, pertaining to more complex cognitive functions such as critical thinking, evaluating ideas, generating ideas, and engaging in creative activities, rather than merely performing surface-level tasks. As such, this factor can be deemed to represent the active and deep learning processes that students experience when using GenAI. A deep approach to learning is characterised by students' desire to thoroughly understand and meaningfully engage with the material. It involves focusing on key concepts and principles and applying strategies that effectively foster the creation of meaning (Asikainen & Gijbels, 2017; Vanthournout et al., 2014). Strategies used by students who have a deep approach to learning include connecting new ideas with prior knowledge, identifying patterns, evaluating ideas and critically assessing arguments (Baeten et al., 2008).

The second factor comprises seven items (see Table 2). Based on the nature of these items, the second factor was named "Frequency of GenAI Use for Supporting Learning". The activities associated with this factor involve the use of GenAI in tasks that provide learning support to students, without engaging with students' higher-order cognitive skills such as critical thinking or creativity. Examples of such activities are generating quizzes, generating study guides, generating answers to assignments – which suggest students seeking shortcut to receive straightforward answers, providing feedback, translating languages, and finding references to research papers. These are activities involving the use of GenAI for supportive, lower-level tasks that streamline the assignment preparation process and do not require deep, complex cognitive engagement. According to Vanthournout et al. (2014), the surface approach to learning involves behaviour driven by external motivations or intentions that are unrelated to the true purpose of learning, such as a fear of failure.

Dependent variables

The dependent variables of interest in this study are:

1. "I would like to see generative AI being formally incorporated into the university curriculum."
2. "I would like to see generative AI being formally incorporated into the university assessment."
3. "I am receptive to the idea of having my assignment marked, graded and commented by AI instead of my instructor."

The first dependent variable of this study (desire for GenAI incorporation into the university curriculum *and* assessment) was derived by calculating the average response to Questions 1 and 2.

Questions 1 and 2 represent the respondents' attitudes toward incorporating GenAI into the university curriculum and assessment, in other words, the interest in integrating GenAI into the university's educational system. The curriculum, as defined by Organisation for Economic Co-operation and Development (1998, p. 33), is a field of enquiry and action on all that bears on schooling, including content, teaching, learning and resources. It covers the design and delivery of educational content, while assessment involves evaluating and measuring learning outcomes. Given that assessment is an essential and integrated part of the curriculum, both areas are closely related. Hence, this construct was named "GenAI Incorporation in Curriculum and Assessment."

Question 3 was examined separately as the second dependent variable. It was prudent to do so, given the potential for differing attitudes towards using GenAI for marking as opposed to general integration of GenAI into curriculum and assessment. This enabled a better understanding of whether there was a significant difference in how respondents view the general integration of AI into education versus its evaluative role in taking over human marking, grading and feedback. The idea of GenAI taking over such duties might provoke a response that is different from students' general attitude towards GenAI integration in curriculum and assessment. It is possible that respondents could be comfortable with GenAI being part of the curriculum and assessment design, but less so with GenAI making evaluative decisions that directly impact their academic outcomes. Separating the analysis helps to capture these nuances accurately, providing clearer insights into specific attitudes towards GenAI's role in marking. If the average of Questions 1 and 2 were to indicate a high level of acceptance, while Question 3 showed a lower receptiveness, it would suggest that while respondents were open to GenAI as a tool for enhancing education, they may still have reservations about entrusting GenAI with marking, grading and feedback responsibilities. Discovering varying levels of acceptance or resistance towards the use of GenAI for marking as opposed to general integration of GenAI into the curriculum and assessment can help educators and policymakers develop more targeted strategies or interventions regarding GenAI's role in education.

Analysis and discussion

Data analysis

This study aimed to identify the key determinants of the respondents' desire to see GenAI incorporated into the university's curriculum and assessment as well as the main factors influencing the respondents' willingness to have GenAI mark their assignments.

A total of 790 participants were surveyed, but only 531 met the respondent profile requirements set out by four qualification questions requiring that they be 18 or older and enrolled in an under or postgraduate programme at that university, that they had heard of generative AI and had used it for text generation. However, only 355 of these 531 qualified survey participants responded to the questions pertaining to GenAI incorporation into the university's curriculum and assessment as well as the one about their willingness for GenAI to mark their assignments. To determine whether the fact that only 355 out of 531 qualified survey participants responded to the questions might affect our study's results, statistical tests were conducted to compare the attitudinal profiles—specifically, the GenAI usage frequency—of respondents and non-respondents to these questions. An analysis was carried out to determine whether there were significant differences between the two groups in terms of their GenAI usage frequency for higher-order learning and for supporting learning. The results indicated no significant differences between respondents and non-respondents in these measures. Therefore, there is no evidence to suggest that the 176 participants who did not respond had any adverse effects on the results derived from the 355 respondents who answered the questions.

To analyse the data collected, a chi-square automatic interaction detection (CHAID) model was used with IBM SPSS Modeler. The CHAID algorithm is a decision tree technique commonly used for effect assessment and prediction. Generally, the most important determinant among the independent variables (as indicated by its p-value) splits the sample analysed into two or more subgroups, called nodes (Koh, 2005). Following preset split condition parameters (such as statistical significance thresholds and minimum post-split sample size), the process is repeated with the next most important determinant/s, splitting one/some of these subsets into smaller subgroups further down the tree. The splitting process terminates when no further significant variables can be associated with the independent variable, giving the final decision tree.

In this study, CHAID was used to generate two distinct decision trees. The first one analysed the relationship between the respondents' desire to see GenAI incorporated into the university curricula or assessment and five socio-educational factors as determinant variables, namely: age, gender, race, frequency of GenAI use for higher learning, and frequency of GenAI use to support learning. The second decision tree carried out a similar analysis on the association between these same determinants and the respondents' willingness to let GenAI mark their assignments.

To identify the best determinants of the respondents' desire to see GenAI incorporated into the university curricula or assessment, the CHAID algorithm created a 9-node, 3-layer decision tree (Figure 2).

Node 0 comprises the final sample of 355 survey participants who were asked the extent to which they agreed with the statement, "*I would like to see generative AI being formally incorporated into the university curriculum and assessments*". The average response score was 3.565, which falls mid-way between "neutral" to "somewhat agree".

At the first level, the decision tree indicates a very statistically significant (p=0.000) positive association between the respondents' desire for the university to incorporate GenAI into its programme curricula and assessments and their GenAI usage frequency for higher-order learning. The monotonic relationship reveals that the more frequently the respondents used GenAI for higher-order learning, the more

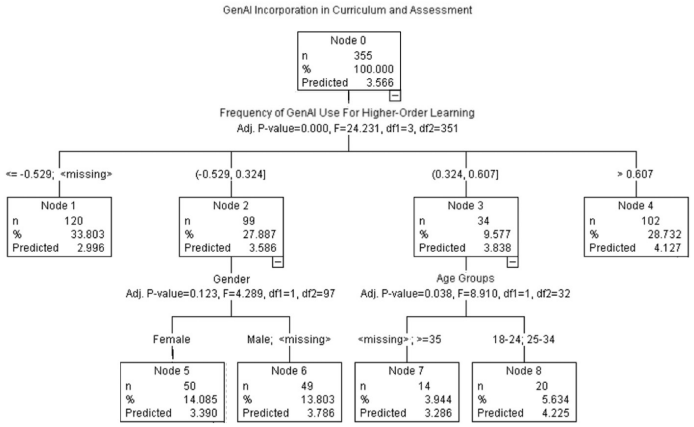

Figure 2. Decision tree for GenAI incorporation in curriculum and assessment.

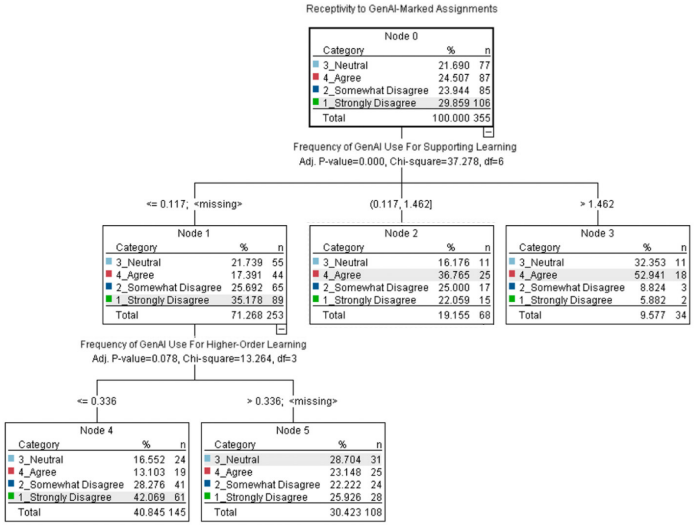

Figure 3. Decision tree for receptivity to GenAI-marked assignments.

they would like to see it formally incorporated into their curriculum and assessment (see nodes 1 to 4 in Figure 2).

Furthermore, for the group of respondents whose GenAI usage frequency for higher-order learning was above average but not very high (node 3), the younger group of 18-34 (node 8) tended to have a stronger desire to see GenAI incorporated into the curriculum or assessment as compared to the older group of 35 year-old and above (n=11) as well as those who did not state their age (n=3) (node 7).

Finally, it was noted that in the group of respondents whose GenAI usage frequency for higher-order learning was average (node 2), there is a marginal statistically significant difference (p=0.123) between male (n=41) and those who did not indicate their gender (n=8) versus female respondents, with the former (node 6) having expressed a stronger desire to see GenAI incorporated into the curriculum and assessment than the latter (node 5).

The CHAID algorithm was also used to identify the determinants of the respondents' willingness for GenAI to mark their assignments, resulting in a second 6-node, 3-layer decision tree (Figure 3).

As shown by the splits below node 0, there was a very significant (p=0.000) positive association between how receptive the respondents were to having GenAI mark their assignment and their GenAI usage frequency to support their learning – that is, the more frequently they used GenAI in learning support contexts, the more receptive they were to letting it mark their assignments (see nodes 1 to 3).

Furthermore, it is noted that within the group of respondents whose GenAI usage frequency in learning support contexts was low (node 1), 70.34% of those whose GenAI usage frequency for higher order learning was also low tended not to be receptive to the idea of letting GenAI mark their assignments (node 4). On the other hand, however, 51.85% of the respondents whose GenAI usage frequency for higher-order learning was high (n=92) or missing (n=16) either had no objection or were agreeable to GenAI being used to mark their assignments (node 5). It can be argued that as these respondents use GenAI in contexts involving in-depth and more complex learning, they might be perceiving GenAI's knowledge but also analytical and reasoning capabilities to be sufficiently sophisticated for them to consider GenAI to possess sufficient domain expertise to mark their assignments.

Finally, although they were included in both CHAID analyses, it should be noted that neither *race* nor *years of study* were found to be determinant of the two dependent variables that this study examined.

Discussion

This study used two CHAID analyses to examine the strongest determinants of the respondents' desire to see GenAI incorporated into their course curriculum and assessment as well as with their willingness to let GenAI mark their assignments.

An analysis of the data reported by the first decision tree found that the respondents' GenAI usage frequency for higher-order learning was the most important factor determining their desire to see GenAI incorporated into the university's curriculum and assessment while gender was found to be a marginally significant determinant, but only for a subgroup of those whose GenAI usage frequency for higher-order learning was above average, but not very high. It is suggested that the GenAI use for higher-order learning was found to be a determinant of the respondents' willingness to incorporate GenAI in Curriculum & Assessment because many of the higher-order learning variables relate to course content (therefore to curriculum), such as GenAI use for complementing course materials, learning advanced topics, and summarising content, as well as for assignment preparation (assessment), including developing critical thinking skills, gaining creative inspiration, brainstorming and evaluating ideas, and reviewing and improving writing, as shown in Table 2. Hence, since this particular group already uses GenAI informally in these contexts, they are more familiar with its capabilities and it therefore appears likely that to maximise its benefits, they would want the

university to formally incorporate GenAI in the development and content of the course curriculum and assessment.

An analysis of the second decision tree found that the frequency of GenAI use for learning support was the most important determinant of the students' willingness to have GenAI mark their assignments, followed by its frequency of use for higher-order learning. This could be explained by the fact that many of the learning support variables relate to assignment preparation, such as GenAI use for generating partial or full answers to assignments, finding references for research papers, and providing feedback on assignment answers before submission. Similarly, some higher-order learning variables (as shown in Table 2), such as developing critical thinking skills, getting creative inspiration, brainstorming, evaluating ideas, and improving writing, also contribute to this willingness. As such, it appears logical and, as the results showed, that it is likely the respondents who frequently use GenAI to prepare their assignments would tend to understand and trust its capabilities and would hence be more receptive to having GenAI mark their graded submissions.

Conclusions and recommendations

The purpose of this research was to identify the factors that affect the learners' openness to integrate GenAI in the curriculum, assessment methods, and assignment marking of the courses they take at the university.

The study found that the respondents' familiarity with GenAI, as measured by how frequently they use it, was positively associated with their attitude and trust towards it as they were more willing to see it being incorporated in their studies, for content and assessment development as well as for assignment marking. This is aligned with Stöhr et al. (2024) whose research concluded that a strong positive correlation exists between familiarity with ChatGPT and favourability of attitude towards such tools.

In addition, for some learners with an above-average familiarity with GenAI, the study findings suggest that age was also a significant factor, with the younger 18-34 learners having a more positive attitude and trust towards this technology than those 35 and above. Although this research investigated Singapore learners at a local university, its findings are coherent with those of Draxler et al. (2023), who concluded that younger US citizen users were more likely to use GenAI than older ones.

These findings should prompt universities to implement the following recommendations.

Firstly, universities should develop and issue a formal statement describing, but also circumscribing the role that GenAI plays at their institution so as to broadly address both the opportunities and challenges presented by this technology. This is especially important so that the students and faculty easily understand what they are allowed and not allowed to do with GenAI.

To operationalise that statement, universities should then develop clear, transparent and comprehensive policies governing how GenAI ought to be used in learning, assessment, and assignment marking, including clear guidelines on the ethical use of GenAI tools, particularly in the context of academic integrity, to prevent misuse such as plagiarism or over-reliance on AI-generated content.

They should also ensure that prior to the beginning of every semester, these policies are communicated effectively to all students and faculty while paying particular attention to the concerns of those who may be less familiar or less trusting of this technology.

Thirdly, universities should promote GenAI literacy by developing training courses on the use of AI technologies in an academic setting, encouraging, in particular, its older student population to learn to engage with GenAI through a series of online or face-to-face workshops and tutorials. Similar training could also be developed for faculty so that they can learn to integrate GenAI into the course curriculum and assessment as well as into their teaching practices.

Fourthly, starting with one or two courses in each discipline, universities should gradually incorporate AI into the content and assessment of its courses so as to allow students and faculty to gradually adapt to this new reality and become sufficiently confident to engage it within the limits set out by the institution. During the implementation of these pilot programmes, it should also gather feedback from both younger and older learners to refine its implementation approach.

Fifthly, universities should continuously seek inputs and feedback through formal channels of communication and forums for students and faculty to discuss the use of GenAI in education. This can help them address concerns, share experiences, and build a community of practice around GenAI, enhancing trust and positive attitudes across all age groups.

Finally, with the feedback gathered on the effective use of GenAI in education, universities should regularly revisit and refine both their GenAI statement and policies so that they remain current, relevant and useful in addressing the new benefits and challenges of this fast-evolving technology.

At the same time that this research was conducted, there were parallel GenAI policy and practice developments within the university where the data was collected (hereinafter "the University"). Although developed independently, our research and the University initiatives outlined below do complement and often reinforce each other. The University's initiatives validate the study's recommendations, and the latter provide support for the parallel developments at the University.

In early 2024, the University formed an AI taskforce comprising faculty representatives from its various schools, Teaching and Learning Centre as well as from its learning technology and E-learning media and resource departments. Given a six-month mandate, the taskforce was asked to explore the challenges and opportunities that GenAI bring

to higher education and offer faculty and staff guidance on best practices for implementing GenAI in adult learning environments.

A comprehensive "Generative Artificial Intelligence Policy" was added to the Student Handbook, describing in detail the contexts, learning situations and conditions under which students are allowed and not allowed to use it, along with the disciplinary sanctions they could face when these rules are violated. To raise awareness of this policy, every teaching faculty use a set of slides explaining its main tenets to their students. In addition, the University also provides its staff and teaching faculty a GenAI policy for teaching and learning. Furthermore, the University's Teaching and Learning Centre developed a series of short courses for students regarding the responsible use of GenAI in their assignments, highlighting the citation requirements as well as the guidelines to follow in order to avoid sanctions pertaining to plagiarism.

To guide the faculty on the use of GenAI for course development, assessment and teaching, the taskforce developed a series of documents on the assessment modes and GenAI usage that are appropriate to the learning outcomes of different course levels and subjects so that through their assignments, students can develop their core skills independently of GenAI while ensuring that they also learn to effectively use it during their studies, ensuring that they are ready when they embark or continue their career.

Finally, the University library has published a microsite on GenAI outlining the main categories of AI tools along with specific AI applications that students and instructors can use, along with resources on their responsible use. It also provides additional links to subscribed resources.

Limitations & future research

While providing some valuable insights, this study is affected by a number of limitations. Firstly, the respondents' profile was restricted to students from a Singapore-based autonomous university and this may limit the generalisability of the findings to broader populations. Hence, a larger, more diverse sample would have enhanced the external validity of the results.

Secondly, the research design and methodology, while robust, may not fully capture all relevant variables, potentially overlooking nuanced aspects of the respondents' attitude towards GenAI that was under investigation.

Future research should address these limitations by using sampling methods that target larger and more diverse samples that better represent the overall student population. Furthermore, as GenAI is quickly becoming more pervasive, these studies should focus more on the perceived or real impact it has on, for instance, the students' learning journey, their achievement of course learning outcomes, the skills that they need to properly harness its power as well as the skills that they should develop so that they remain employable and relevant in the job market.

Regardless of the focus of future studies on GenAI, it is undeniable that this technology has barely started to disrupt how students learn, instructors teach, and faculty develop courses and conduct research. As GenAI becomes increasingly more powerful and sophisticated, its influence will only spread wider and deeper into every aspect of education. The pace as much as the scope of its growing influence presents governmental as well as educational authorities with the particularly difficult challenge of harnessing this technology to enhance teaching, learning and research while ensuring that its adoption and integration do not destroy the learners' ability and motivation to acquire knowledge nor the faculty's incentive to participate in its creation. To avoid such a negative outcome, universities should set up a formal GenAI usage feedback mechanism to ensure that its GenAI policies and practices keep up not only with the current GenAI implementation but, as importantly, with the rapid advancement of GenAI tools in both versatility and sophistication.

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Digital learning resources and student success: Analyzing engagement and academic performance

Adam Wong[A] A *Senior Analytics Lead, Business Intelligence & Analytics, Singapore University of Social Sciences*

Wee Leong Lee[B] B *Associate Professor & Vice President, Learning Services, Singapore University of Social Sciences*

Matthew Shun Liang Chan[C] C *Specialist, Business Intelligence & Analytics, Singapore University of Social Sciences*

Yi En Tan[D] D *Undergraduate Student, Singapore University of Social Sciences*

Jennifer Mui Kheng Huang[E] E *Associate Professor (Practice) & Director, Educational Media & Resources, Singapore University of Social Sciences*

Yew Haur Lee[F] F *Associate Professor & Director, Business Intelligence & Analytics, Singapore University of Social Sciences*

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Correspondence

adamwongch@suss.edu.sg [A]

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Abstract

This study examines the impact of student engagement with digital learning resources – specifically sustained, timely, and distributed interactions with Learning Management Systems (LMS), e-textbooks, and digital study guides – on academic achievement outcomes in higher education. Using multiple regression analysis on data from 1,591 undergraduate students, the research identifies LMS engagement as a significant predictor of academic success, with specific behaviors such as prompt and consistent access strongly associated with academic performance. In contrast, e-textbooks and study guides play a more supplementary role. By incorporating confounding variables like age, gender, and academic mileage, the study offers a nuanced understanding of these relationships, underscoring the importance of an integrated approach to enhancing student engagement and learning outcomes.

Introduction

The rapid digitalization of higher education, accelerated by the COVID-19 pandemic, has transformed how students engage with course materials and manage their learning processes. Learning Management Systems (LMS), digital study guides, and e-textbooks have become ubiquitous in modern educational settings, offering students unprecedented access to information and flexible learning opportunities. At the Singapore University of Social Sciences (SUSS), study guides serve as a learning resource, designed to facilitate self-directed learning. These guides provide a structured roadmap for students, helping them to focus on key concepts and effectively manage their independent study time. While LMS and e-textbooks are commonly used across higher education institutions, the integration of comprehensive study guides is a distinctive feature at SUSS, providing a more structured approach to asynchronous learning. These digital resources address the limitations of traditional classrooms by creating an interactive learning environment, providing faster feedback and enhancing student engagement. The significance of digital learning infrastructure became clear during the COVID-19 pandemic, which limited students' ability to attend classes in person. During this challenging time, digital technologies sustained the education system and allowed students to continue learning from home (Haleem et al., 2022). As educators and institutions increasingly invest in these technologies, it is crucial to understand not only their direct impact on academic performance but also how they foster student engagement, a key driver of academic success. Recent studies indicate that the way students interact with digital learning resources – through behaviors like frequency and consistency of access – significantly influences their motivation and academic outcomes (Lin et al., 2017a).

To fully harness the benefits of digital tools, it is essential to recognize the vital role of student engagement in academic success. Engagement with educational resources not only enhances learning but also promotes better organizational skills and time management (Kuh et al., 2008). Recent studies continue to affirm that student engagement is vital for academic achievement. For instance, Wolters and Brady (2021) emphasize that students who actively manage their time and engage with their learning resources tend to perform better academically, underscoring the importance of engagement.

As the shift from physical classrooms to digital platforms accelerates, maintaining student engagement in these environments has become crucial (Baloran et al., 2021). LMS, which serve as centralized hubs for course content, assignments, and communication, are specifically designed to promote such engagement (Dahlstrom et al., 2014; Brooks & Bichsel, 2014). However, as highlighted in the literature, merely providing access to an LMS does not ensure meaningful engagement or improved academic performance (Arnold & Pistilli, 2012). This underscores the necessity for strategies that not only facilitate access but also actively encourage student interaction with these platforms, as active engagement is crucial for achieving academic success.

Similarly, digital study guides and e-textbooks have proven to support student learning by offering structured, interactive, and accessible content. Study guides help students focus on key concepts and develop effective study habits, leading to better academic outcomes. E-textbooks, with their interactive features and multimedia content, can enhance comprehension and retention, particularly when students actively engage with the material (Rockinson-Szapkiw et al., 2013). Nevertheless, the impact of these resources on academic performance varies based on the quality of engagement and individual student preferences (Lin et al., 2017b). Effective engagement with digital resources requires not just access but also thoughtful design, tailored to the needs and preferences of students. Zeivots and Shalavin (2024) emphasize the importance of co-designing course materials to enhance student interaction and learning outcomes, particularly in online environments. While engagement is crucial, it is not the sole primary factor influencing better outcomes. The quality of course materials plays a fundamental role in supporting effective learning. However, even the most well-crafted course materials may not yield optimal outcomes if students are not actively engaged with them. Engagement involves the behavioral, emotional, and cognitive aspects, all of which contribute to a student's willingness to invest effort and persist in learning tasks. Hence, both the quality of course materials and student engagement are integral to achieving better academic outcomes. Consequently, educators should focus on designing high quality materials and implementing strategies to encourage student engagement to enhance learning outcomes.

Despite the many advantages of digital learning resources, understanding how student behavior and engagement with these tools influence academic outcomes is essential for making informed decisions about resource allocation and instructional design. However, in an increasingly digital and interconnected world, the existing literature remains sparse in addressing the characteristics of student engagement in online learning (Paulsen & McCormick, 2020). This study aims to fill that gap by exploring the relationship between student engagement with digital learning resources and academic achievement in higher education. Through an analysis of data on LMS access, study guide usage, and e-textbook interaction, we seek to identify the key engagement behaviors most predictive of academic success.

Literature review

Digital learning resources and their impact on student engagement and academic success

A Learning Management System (LMS) is a web-based platform designed to meet student needs by supporting the delivery, administration, and management of courses (Aldiab et al., 2019). LMSs are integral to modern education, providing centralized access to course materials, facilitating communication, and enabling student progress tracking. These platforms enhance engagement through features like discussion forums, quizzes, and assignment submission systems, all accessible via web browsers or mobile devices (Nasser et al., 2011; Kasim & Khalid, 2016).

Beyond providing access, LMS empowers students by enabling them to monitor their academic progress, fostering autonomy and self-regulation (Watson & Watson, 2007; Al-Fraihat et al., 2020). In online learning contexts, where self-initiated participation is key, this autonomy becomes even more crucial (Lin et al., 2017a). Research supports the role of LMS in boosting engagement and performance, with studies showing that regular interaction with LMS tools improves organizational skills, time management, and academic success (Junco & Clem, 2015). However, the effectiveness of LMS depends on active and meaningful engagement with course content (Arnold & Pistilli, 2012; Salas-Pilco et al., 2022). Bond et al. (2020) further emphasize that higher engagement levels, particularly through educational technology, are strongly linked to improved outcomes.

Building on the foundational role of LMS in student engagement, digital study guides complement these platforms by structuring student learning and focusing on key concepts. These guides provide a roadmap that enhances understanding and retention of course material. Effective study guides also promote critical learning strategies like self-explanation and retrieval practice. Moreover, adaptive study guides tailored to individual needs can significantly improve academic outcomes (Agarwal & Bain, 2019). As with LMS, the success of digital study guides relies on their ability to actively engage students in their learning process.

Just as study guides support focused learning, e-textbooks offer a flexible, interactive approach that complements these guides by integrating multimedia elements to enhance comprehension and retention. Research by Lin et al. (2017b) has shown that the specific behavior patterns students exhibit when accessing online learning materials can significantly influence their motivation and learning performance, suggesting that the quality and consistency of engagement are critical to academic success. Features like embedded quizzes, videos, and hyperlinks facilitate active learning and engagement with the material. Daniel and Woody (2013) found that students using e-textbooks often perform better academically compared to those using traditional print textbooks, especially when e-textbooks are well-integrated into the curriculum. However, challenges such as screen fatigue and preferences for printed materials highlight the need for careful implementation of e-textbooks.

Integrating these digital resources in higher education is essential for enhancing learning experiences and outcomes. Educators increasingly leverage LMS, study guides, and e-textbooks to create a comprehensive learning environment. Effective integration requires thoughtful planning and alignment with pedagogical goals (Moore et al., 2011). When seamlessly integrated into the curriculum, these digital resources can significantly enhance student engagement and academic performance (Garrison & Vaughan, 2012). However, variability in digital literacy among students and instructors can pose challenges to effective integration (Bates, 2022).

Educational data mining, learning analytics, and student engagement

To fully leverage digital tools like LMS, digital study guides, and e-textbooks, educational data mining (EDM) and learning analytics (LA) have become vital tools in enhancing student engagement and academic success. These fields involve analyzing large datasets from digital platforms such as LMS, digital study guides, and e-textbooks to identify patterns in student behavior, learning activities, and engagement levels. This analysis allows educators to develop targeted interventions, optimize learning experiences, and improve academic outcomes.

Recent studies emphasize the growing importance of predictive modeling within both EDM and LA. These models help forecast student performance, identify students at risk of failure, and personalize learning experiences to enhance outcomes. The application of machine learning – such as decision trees, neural networks, and support vector machines – has been particularly effective in increasing the accuracy of these predictions, leading to timely and appropriate interventions (Namoun & Alshanqiti, 2021).

Moreover, learning analytics has been shown to be instrumental in enhancing student engagement, especially in online learning environments. By analyzing various forms of student engagement – behavioral, cognitive, social, and emotional – learning analytics provides insights that can be used to tailor educational approaches and support students more effectively. Studies have found that multifaceted engagement approaches, supported by learning analytics, significantly improve students' learning performance (Johar et al., 2023).

As the use of digital tools in education continues to expand, the integration of EDM and LA will become increasingly critical in driving student engagement and academic success. These technologies enable the creation of more personalized learning experiences, directly supporting student achievement by identifying and enhancing the behaviors most predictive of success.

By leveraging the latest advancements in EDM and LA, as discussed in the literature review, this study explores the relationship between student engagement with digital learning resources and academic achievement. At SUSS, where study guides are a central component of the learning strategy, engagement with these resources played a pivotal role in the research. These guides provide students with interactive content designed to complement other digital tools like LMS and e-textbooks. Therefore, the focus on SUSS's unique reliance on study guides differentiates this study from those conducted at institutions where such resources are less integral. This deeper understanding will enable educators and administrators to implement data-driven strategies that enhance digital learning environments and improve student outcomes.

Methodology

Building on the insights from the literature, this study utilized a data mining approach to quantitatively assess the relationship between student engagement with digital learning resources and academic success. By analyzing engagement metrics, this methodology aimed to uncover patterns and correlations that provide a deeper understanding of how digital resources like LMS, digital study guides, and e-textbooks influence academic outcomes.

Data collection

The participants in this study included 1591 undergraduate students enrolled in four courses at SUSS. Data was collected from various digital platforms, including LMS, digital study guides, and e-textbooks. The study focused on the following engagement metrics:

Metric	Description
Immediacy	Measures the time lapse between a start date in access and a student's first online access
Recency	Measures the time lapse between an end date in access and a student's last online access
Frequency	Measures the number of sessions of online access between a start date and an end date in access
Duration	Measures the total access time from each session of online access
Interval	Measures the time lapse between a student's last online access and his first online access relative to the time lapse between a start date and an end date in access
Spread	Measures the dispersion of the sessions of online access
Mean-Gap	Measures the average gaps between successive sessions of online access

Figure 1. Engagement metrics. (Wong & Chong, 2018; Tan & Koh, 2018).

These engagement metrics, initially developed in previous studies by Wong and Chong (2018) and Tan and Koh (2018), were implemented across LMS, digital study guides, and e-textbooks. This study extended previous research by analyzing these metrics with additional demographic and academic performance data, providing a more comprehensive understanding of how various factors influenced student outcomes.

Data preprocessing was essential to ensure consistency and readiness for analysis. The steps involved included normalization, reverse scoring, and the creation of composite engagement metrics. To standardize engagement metrics measured on different scales, min-max normalization was applied, scaling metrics to a common range [0, 1]. Metrics that had an inverse relationship with academic performance were reverse-scored, ensuring that higher scores consistently represented higher levels of engagement. Finally, these processed metrics were combined to create composite engagement scores for LMS, e-textbooks, and digital study guides, which were used as independent variables in the regression analysis.

Multiple regression analysis

Multiple regression analysis was employed to assess the relationship between engagement metrics and academic performance, allowing for the control of confounding variables. This approach enabled us to evaluate the distinct contributions of each engagement metric to academic success, providing deeper insights into how specific behaviors influence academic outcomes.

The regression model included independent variables such as reversed-scored and normalized immediacy, reversed-scored and normalized recency, normalized frequency, normalized duration, reversed-scored and normalized interval, reversed-scored and normalized spread, and reversed-scored and normalized mean-gap, alongside potential confounders (e.g., age, gender). This approach helped to isolate the unique contribution of online engagement behaviors to academic success. We included the following confounders due to their potential influence on both engagement and academic outcomes:

1. Age – Age can influence both engagement and academic performance. Older students might have different learning styles, responsibilities, or time management skills compared to younger students, which could affect how they engage with digital tools and perform academically. For instance, an older student might be more disciplined in engaging with LMS due to work experience, which could lead to better academic outcomes independent of the engagement metrics being studied.

2. Gender – Gender can also influence engagement patterns and academic outcomes. Male and female students may engage with digital learning resources in different ways. These differences in engagement behavior can introduce variability in how students interact with learning tools, potentially confounding the relationship between engagement and academic success. For instance, one gender might be more inclined to use discussion forums, while the other might prefer direct study from e-textbooks. Such differences in engagement approaches could influence academic outcomes in ways that are not related to the engagement metrics themselves but rather to the underlying gender-based preferences in learning behaviors.

3. Company sponsorship – Company sponsorship can significantly influence both student engagement and academic performance. Sponsored students often demonstrate higher levels of engagement, driven by the financial and professional incentives associated with their sponsorship (Barrow & Rouse, 2018). This heightened motivation may lead them to invest more time in their coursework and utilize digital learning resources more effectively. Additionally, the requirements often tied to sponsorships, such as maintaining a specific grade-point average or achieving certain academic milestones, create a stronger sense of obligation to perform well academically. This external motivation can positively influence academic outcomes, independent of the

students' engagement with digital learning resources. Therefore, company sponsorship is a critical factor to consider in the analysis, as it may confound the relationship between engagement metrics and academic performance by contributing to improved outcomes through mechanisms unrelated to digital engagement.

4. Years since last study – Years since last study can be a significant potential confounder. Students returning to study after many years might require a period of adjustment to re-acquaint themselves with academic expectations, new learning technologies, and the pace of study. This adjustment period could affect their initial performance and engagement, confounding the relationship between engagement metrics and academic success. Furthermore, students who have been out of an academic setting for an extended period may experience a decline in study habits, academic skills, and familiarity with the learning environment. This atrophy can negatively impact their academic performance, regardless of their engagement with digital learning resources.

5. Academic mileage – "Academic mileage" refers to the cumulative academic experience that a student accumulates over time, measured through various indicators of academic engagement and performance. In this study, academic mileage data includes variables such as total credits units taken, withdrawn, failed, and completed.

Academic mileage variables are potential confounders for the following reasons:

a. Total credit units taken – A student who has taken more courses may have broader academic experience, leading to better-developed study habits that can independently influence their academic performance. Their improved outcomes may result from greater exposure to course material, rather than directly from higher engagement with digital tools. Students with higher total credit units taken may engage differently with digital tools because they have more experience and familiarity with the platforms. They may also be better at managing their time and resources, which could confound the relationship between engagement metrics and academic success.

b. Total credit units withdrawn and failed – These variables might reflect underlying academic difficulties or external challenges that could independently affect both engagement and academic outcomes. A student who frequently withdraws or fails courses might have lower engagement and academic performance due to factors unrelated to the use of digital learning resources, such as personal, financial, or health issues. Furthermore, external pressures such as balancing work and study could independently influence their level of engagement with digital tools.

c. Total credit units completed – The number of completed courses may indicate persistence and academic success, which could be associated with both higher engagement and better academic outcomes. Students who have completed more courses might engage more effectively with digital tools due to accumulated experience and familiarity with the academic system. This could lead to higher academic performance, confounding the relationship between current engagement metrics and academic outcomes.

Analysis and discussion

This section presents the results of our analysis, which proceeded in two phases. First, we examined the impact of composite engagement metrics for Learning Management Systems (LMS), e-textbooks, and digital study guides on academic performance, as measured by final weighted course scores. These composite metrics were constructed to encapsulate the overall engagement levels by aggregating dimensions such as immediacy, recency, frequency, and duration of interactions with digital learning resources.

Following this, we extended the analysis by incorporating individual engagement metrics alongside key confounding variables, including age, gender, company sponsorship, years since last study, and academic mileage. This more detailed examination aimed to uncover the specific aspects of engagement that most strongly influence academic outcomes, while also accounting for other factors that may affect the relationship between engagement and performance.

Phase 1: Analysis of composite engagement metrics

In the first phase of our analysis, we assessed the impact of composite engagement metrics for Learning Management Systems (LMS), e-textbooks, and digital study guides on academic performance, as measured by final weighted course scores. These composite metrics were designed to capture the overall engagement levels across multiple dimensions, such as immediacy, recency, frequency, duration, interval, spread, and mean-gap.

The multiple linear regression analysis revealed that the composite engagement metric for LMS had a significant positive relationship with academic performance. Specifically, the coefficient for LMS engagement was 8.4468 ($p < 0.001$), indicating that higher levels of engagement with the LMS were strongly associated with better academic outcomes. This finding aligns with existing literature that emphasizes the importance of structured and consistent interaction with course materials for academic success (Kuh et al., 2008).

In contrast, the composite engagement metrics for e-textbooks and digital study guides did not show a statistically significant relationship with final weighted course scores. The coefficient for e-textbook engagement was -0.3014 ($p = 0.254$), and for study guide engagement, it was -0.2343 ($p = 0.438$). This result indicates that the impact of these tools on academic success may be more complex, potentially depending on individual study habits or the specific integration of these resources within the learning process.

Several factors could explain the lack of significance for e-textbooks and study guides. As discussed in previous studies, the way students interact with these tools might not be as consistent or structured as their interaction with the LMS. Unlike the LMS, which often serves as the central hub for course-related activities, e-textbooks and study guides might be used more sporadically, depending on individual study habits and preferences. Additionally, students may print digital study guides and rely on physical copies, which are not captured in the engagement metrics collected from digital platform.

The model's R-squared value of 0.122 indicates that the composite engagement metrics collectively explain about 12.2% of the variance in academic performance. This suggests that while engagement with digital learning resources is indeed a factor in academic success, a significant portion of the variance is influenced by other factors, underscoring the complexity of academic performance (Arnold & Pistilli, 2012).

Overall, these findings contribute to the broader literature by reinforcing the critical role of LMS engagement in academic success, while also underscoring the need for a more nuanced understanding of the roles that e-textbooks and digital study guides play in diverse learning contexts. These results underscore the importance of timely and consistent LMS engagement, raising critical questions about the optimal integration of other digital tools, such as e-textbooks and study guides, to fully realize their educational potential.

Phase 2: Analysis of individual engagement metrics and confounding variables

Building on the insights gained from the composite metrics analysis in Phase 1, Phase 2 delves deeper into individual engagement behaviors and their specific impact on academic outcomes, while accounting for various confounding factors. This enhanced model aimed to isolate the distinct contributions of individual engagement metrics, offering a more nuanced understanding of how these behaviors influence academic performance. The key findings are:

1. LMS immediacy – The analysis revealed a significant positive relationship between the LMS immediacy metric and academic performance ($\beta = 9.772$, $p < 0.001$). This indicates that students who promptly accessed LMS resources after they became available were more likely to perform well academically. This underscores the critical role of timely engagement with learning materials, reinforcing the notion that prompt access to course resources is essential for academic success.

2. LMS recency – The LMS recency metric also demonstrated a significant positive association with academic performance ($\beta = 6.4745$, $p < 0.001$). Students who accessed LMS resources more recently, in relation to the course timeline, tended to achieve higher grades, further emphasizing the importance of consistent engagement throughout the course.

3. LMS interval – The LMS interval metric, calculated as the time span between a student's last and first access, divided by the overall course access window (end time minus start time), emerged as another significant predictor of academic success ($\beta = 4.8464$, $p < 0.001$). This metric reflects how evenly a student spreads their engagement across the course duration. The positive association suggests that students who distributed their LMS resource access more evenly over time, rather than concentrating it at certain points, tended to perform better academically.

4. E-textbook mean-gap – The mean-gap metric for e-textbook usage was significantly associated with academic performance ($\beta = 1.9402$, $p = 0.001$). This suggests that students who interacted with e-textbooks more frequently, with shorter gaps between sessions, were more likely to achieve better academic outcomes. This finding points to the importance of regular and consistent e-textbook engagement for enhancing academic performance.

5. Other e-textbook metrics – Interestingly, other e-textbook engagement metrics, such as frequency and interval, did not show significant relationships with academic performance. This suggests that while regularity in e-textbook usage (as captured by the mean-gap metric) is crucial, other aspects of e-textbook engagement may not be as influential in this context.

6. Non-significance study guide metrics – None of the study guide engagement metrics were significantly related to academic performance in this model. This suggests that the impact of digital study guides on academic outcomes might be more complex, depending on how they are used with other learning tools. It may also imply that study guides serve better as supplementary resources rather than primary learning tools.

Confounding variables

1. Total credit units taken – This variable exhibited a small but significant negative relationship with academic performance ($\beta = -0.0086$, $p = 0.035$). This suggests that students who enrolled in

more courses might experience a slight decline in their average performance, potentially due to the increased workload and divided attention.

2. Total credit units failed – This variable was negatively associated with academic performance (β = -0.0460, p = 0.002), which is expected as it reflects prior academic difficulties.

3. Age – The analysis indicated a slight negative impact of age on academic performance (β = -0.0167, p = 0.030), suggesting that older students might encounter challenges, such as balancing study with other responsibilities, which could affect their grades. Additionally, age might influence engagement patterns with digital resources. Older students might approach LMS usage and other resources with different expectations or preferences, potentially engaging more strategically or cautiously compared to younger students who might be more accustomed to frequent and diverse interactions in digital learning environments. These differences in engagement approach – intensity and style of engagement – could contribute to varying academic outcomes.

4. Company sponsorship – The indicator that students were not sponsored by a company was associated with lower academic performance (β = -0.1411, p = 0.008). This finding suggests that students without sponsorship might achieve lower academic outcomes, due to the lack of additional financial and professional incentives that could enhance their motivation and performance.

5. Gender – Gender did not show a significant impact on academic performance (β = -0.1124, p = 0.870), indicating that engagement metrics influenced academic performance similarly across genders in this context.

The model explained 41.3% of the variance in academic performance, a substantial improvement from the Phase 1 model. This suggests that incorporating individual engagement metrics and confounders provides a more detailed and accurate understanding of the drivers behind academic success. The F-statistic of 34.27 ($p < 0.001$) confirmed the overall significance of the model.

Conclusions and recommendations

This study's findings from both Phase 1 and Phase 2 offer important insights into how student engagement with digital learning resources affects academic performance. By examining composite and individual engagement metrics, we not only reaffirm the critical role of timely and consistent engagement but also reveal how different digital resources contribute uniquely to academic outcomes. In the next section, we detail key takeaways regarding the importance of LMS engagement, the supplementary role of other digital resources, and the influence of confounding variables, followed by recommendations for educators and policymakers.

LMS engagement as a key driver of academic success

One of the primary conclusions from Phase 1 is the central role that Learning Management Systems (LMS) play in supporting academic success. Consistent with existing literature (Kuh et al., 2008), we find a strong positive association between LMS engagement and academic performance, highlighting the importance of structured, ongoing interaction with course materials. This suggests that LMS, when utilized effectively, can be instrumental in fostering sustained engagement and improving academic outcomes.

Phase 2 builds on this by showing that specific LMS behaviors – such as immediacy, recency, and the distribution of access over time – are significant predictors of success. Students who engage regularly and promptly with LMS resources tend to achieve higher grades, underscoring the importance of not only providing access to digital tools but also promoting their timely and consistent use. This highlights the potential impact of institutional strategies that encourage these patterns of engagement.

To prompt this level of engagement, institutions can consider the following strategies:

1. Automated reminders and alerts – Setting up automated reminders within the LMS can encourage students to engage promptly with new content and assignments. Notifications for upcoming deadlines, available resources, and suggested study schedules can help students manage their time effectively and promote frequent engagement.

2. Learning analytics – Learning analytics can further enhance tech-enabled learning by allowing educators to monitor engagement in real-time and personalize interventions. For example, analytics could help identify students at risk of disengagement early on, enabling timely support. A real-time dashboard could allow educators to track key engagement metrics, identify patterns of low engagement or disengagement, and intervene when necessary. By supporting timely intervention, this tool can help educators keep students on track throughout the course.

3. Student-facing engagement dashboard – Introducing a student-facing engagement dashboard could empower students to monitor their own engagement patterns, supporting self-agency and fostering self-regulated learning. This can encourage students to take responsibility for their learning, make adjustments when necessary, and see the direct link between their engagement habits and academic performance.

4. Faculty engagement and reminders – Faculty can play a critical role by regularly updating content, responding to discussion posts, and sending periodic messages encouraging students to check LMS materials. Active instructor involvement can signal to students that engagement is expected and valued.

E-textbooks and study guides: Supplementary, not primary tools

The non-significant results for e-textbook and study guide composite metrics in Phase 1, combined with the mixed results from individual metrics in Phase 2, suggest that these tools may play more of a supplementary role in the learning process. While regular and consistent interaction with e-textbooks (as captured by the mean-gap metric) was associated with better academic performance, other aspects of e-textbook engagement and all study guide metrics did not show a significant impact.

This may reflect how students use these tools – more sporadically or as supplementary resources rather than primary learning platforms. These findings align with previous research, which suggests that while e-textbooks and study guides are valuable, their impact on academic outcomes may depend on individual study habits and how these resources are integrated into the broader learning environment. Future course designs should consider incorporating student feedback and co-design processes to enhance engagement with digital readings, as suggested by Zeivots and Shalavin (2024), to maximize the effectiveness of these resources.

The role of confounding variables

The inclusion of confounding variables such as age, gender, company sponsorship, years since last study, and academic mileage in Phase 2 provided a more nuanced understanding of the factors influencing academic performance. The significant negative impact of variables such as total credit units taken, total credit units failed, and age on academic performance highlights the importance of considering a student's broader academic and personal context when evaluating their engagement and success.

Interestingly, the negative association between company sponsorship and academic performance, where students without sponsorship performed worse, underscores the potential motivational benefits of external financial and professional incentives (Barrow & Rouse, 2018). This finding suggests that company-sponsored students might be more motivated to engage with digital tools and achieve higher academic outcomes, due to the additional pressure to meet sponsorship requirements.

Conversely, this finding also implies that self-financed students, who might experience greater financial and emotional pressures, could struggle to balance the demands of work and study, potentially leading to lower engagement with digital resources. The added pressure from self-financing could detract from the time and energy available for academic tasks, affecting their academic performance and overall well-being. Institutions could consider offering self-paced and hybrid course formats that can help self-financed students better balance work and study or providing targeted financial aid, scholarships, or grants aimed at self-financed students to alleviate some of the stress associated with funding their education. Additionally, offering academic support, such as coaching or time-management workshops, could help these students develop effective strategies to maintain engagement.

Implications for educators and policymakers

These findings have several important implications for educators and policymakers in higher education. The significant role of LMS engagement in driving academic success suggests that institutions should prioritize the effective deployment and integration of LMS. However, not all engagement is equally beneficial; the type and quality of engagement are crucial in fostering positive academic outcomes.

Research from this study highlights that specific types of LMS engagement – such as immediacy, recency, and the distribution of access over time (interval) – are key predictors of success. *Immediacy*, which reflects how promptly students engage with new content, supports timely learning and reduces the risk of falling behind. *Recency*, or how recently students accessed LMS resources relative to course timelines, indicates sustained engagement and consistent revision, which aids retention of course deliverables and learning objectives. Finally, *Interval*, which refers to spreading engagement evenly across the course duration, discourages last-minute cramming and promotes a steady learning pace.

For educators, these findings suggest that prompting timely, sustained, and well-distributed engagement is more effective than encouraging general LMS access. Institutions can foster these types of engagement through targeted reminders and timely updates, regular and small assignments, and encouraging consistent progress by designing structured check-ins with students. By focusing on these specific engagement behaviors, institutions can better support students' academic success and make LMS interactions more meaningful and beneficial.

Looking forward, as LMS technology develops with Artificial Intelligence (AI), these strategies could be further strengthened. AI-driven tools such as personalized content recommendations, adaptive learning paths, and predictive analytics could support students based on their unique engagement patterns. These advancements could make LMS platforms even more responsive and supportive of individual learning needs, further enhancing the efficacy of the recommendations outlined in this study.

Limitations

This study included 1,591 undergraduate students from SUSS, an institution that emphasizes self-directed learning through digital study guides and e-textbooks. Therefore, the

results may not generalize to institutions that rely less on these tools. Moreover, the SUSS-specific context of learning guides means that their role as supplementary or primary tools may vary significantly in other higher education environments.

Although the study controlled several confounding variables such as age, gender, company sponsorship, and academic mileage, other unmeasured factors may still influence academic performance. For example, study habits or preferences for learning tools might play a role in how digital resources impact student outcomes.

The study focused on the use of digital learning resources, but it did not capture whether students used printed physical copies of digital study guides. This is a potential limitation, as some students may rely on printed versions of these materials for their learning, which could affect their engagement with the digital resources being measured.

The study did not explore the temporal dynamics of engagement over a semester. Engagement behaviors might fluctuate at different points during the academic term (e.g., near exam periods or assignment deadlines), which could affect academic performance. A more detailed analysis capturing these fluctuations might provide a more nuanced understanding of how engagement evolves and impacts outcomes over time.

Future work

Future research could explore these limitations by expanding the study to include a more diverse sample, incorporating self-reported engagement measures, and analyzing additional digital tools. Moreover, further studies could provide deeper insights into the temporal aspects of engagement and its impact on academic outcomes.

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ChemPOV: Evaluating a digital game-based learning tool for organic chemistry through student-researcher collaboration

Panshul Sharma[A] A *NUS High School of Math and Science*

Jovern Teo[B] B *Lee Kong Chian School of Medicine, Nanyang Technological University*

Mattias Wei Ren Kon[C] C *Yong Loo Lin School of Medicine, National University of Singapore*

Jia Yi Han[D] D *Faculty of Science, National University of Singapore*

Fun Man Fung[E] E *School of Chemistry, University College Dublin, Ireland*

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Correspondence

funman.fung@ucd.ie [A]

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Abstract

In this study, we aim to investigate the application of game-based learning in organic chemistry education through the development and implementation of ChemPOV, a digital multiplayer board game. Uniquely, our team involved high school students collaborating with university researchers, providing insights into both the efficacy of the game and the value of engaging young students in chemical education research. Our team conducted trials with 176 junior high school students, divided into control and experimental groups. Data was collected through pre- and post-game surveys and quizzes. Results indicated correlations between student interest, engagement, and enjoyment in organic chemistry, with a minute improvement in academic performance for the experimental group. We also examined the benefits of applied learning experiences for the student researchers, who developed skills in research methodology, game design, and scientific communication. They participated in literature reviews, data analysis, and presented findings at international conferences. This research trial demonstrates the potential of involving young students in substantive research efforts and is a potential model for more inclusive approaches in STEM education.

Introduction

Applied learning is commonly accepted to be the incorporation of academic knowledge and skills into real-world settings, such as corporations, service projects, internships, and undergraduate research (Ash & Clayton, 2009). The motivation behind educators including applied learning techniques in their teaching methodologies is a belief that the contextualisation of the subject matter, drawing relevance between the content being taught and students' future career or further education, will empower and motivate students, whilst also eliciting active participation (Harrison, 2006). In the context of chemical research, applied learning is all the more relevant.

Yet, the introduction of real-world elements to the education of chemistry requires a deeper layer of complexity. Chemistry education has traditionally been plagued with students' inability to comprehend its relevance in the real world despite its reputation as the 'Central Science' (Stuckey et al., 2013). Modern developments in the field, including systems thinking, problem-based learning, as well as game-based learning (GBL), all aim to better engage students and relate their education in the classroom context to real world applications (Orgill et al., 2019; Costa et al., 2023; Putri et al., 2022). These have come a long way in the advancement of chemistry education as a whole. Alongside the development of digital and virtual reality tools, the chemistry education field has evolved greatly (Wohlfart et al., 2023; Laricheva & Ilikchyan, 2023).

Importantly, chemical education research is a highly applied field that has transitioned from individual teacher ideas about how student learning can be improved to a sophisticated enterprise employing the scientific method to formulate and test falsifiable hypotheses through student-focused trials (Bunce & Robinson, 1997; Cooper & Stowe, 2018). For this research to be both fruitful and impactful for chemistry students, it is crucial that chemical education researchers possess both a robust theoretical foundation and the necessary practical skills (Bunce & Robinson, 1997). A strong theoretical base enables researchers to craft effective investigative questions, while practical skills are vital for executing the research process. Although a solid conceptual understanding is linked to research proficiency to some extent, the active and applied use of research skills is necessary. The concept of applied retrieval systems to bolster learning outcomes has been previously documented in the context of undergraduate student learning (Agarwal et al., 2012; Cogliano et al., 2021). Accordingly, just as in the context of student learning, this mechanism is instrumental in fostering continuous improvement in a researcher's ability to conduct studies effectively.

Unfortunately, this very need for experience applying the use of research skills in investigative chemical education trials is often discouraging for young chemistry students, making the chemical education research space seem inaccessible. Examining recent publications in reputable chemical education journals confirms this observation—a very small fraction of these publications constitute high-school or early college students as first or second authors. Changes to undergraduate curricula by inclusion of Course-Based Undergraduate Research Experience (CURE) has been shown to be effective at making scientific research more inclusive and accessible for all students (Bangera & Brownell, 2014). Early research experience can play an important role in the development of students' epistemological (knowledge-based), intrapersonal (self-identity) and interpersonal dimensions (relationships) (Yuhao, 2014). Yuhao's qualitative study on undergraduate research programs in China revealed that such experiences encourage students to develop independent thinking, self-confidence, and collaborative skills. The development of these skills appears tightly associated with good mentorship, including the allowance of student self-authorship. However, such programmes do not exist at every college and are essentially non-existential at the high school level, rendering the research space in general somewhat inaccessible to younger students.

The three lead authors of this article, however, are an exception. Starting as 11th-grade high school students, they established a research partnership with Senpai Learn—a chemistry education research group at the National University of Singapore (NUS). Together, the students worked with Senpai Learn to carry out two separate investigative trials of ChemPOV (Fung et al., 2021), a digital multiplayer organic chemistry game designed in collaboration with the NUS Information Technology department. The results from these trials were analysed and presented by the three lead authors at three separate leading international chemistry conferences. Coaching students in higher education has been previously demonstrated to yield positive development to student metacognition and self-regulated learning skills (Divo et al., 2024). In the case of the student researchers in this group, the mentorship they received whilst under the Senpai Learn team proved valuable to the development of necessary skills in chemistry education research. The team at Senpai Learn adopted the following mentorship strategies that made it conducive for us to develop such skills in chemistry education research: (1) Providing a psychologically safe environment for students, (2) Offering challenging opportunity for growth, and (3) Evaluating and providing timely feedback for students.

For (1), it is essential to foster a space where their opinions are heard without fear of negative judgement. This encourages open communication and allows students to express themselves freely. The Senpai Learn team also helps to provide a safe space for students to make mistakes as making mistakes is essential for learning. Additionally, it is important to cultivate an atmosphere where students feel comfortable seeking help and asking questions without hesitation. By promoting these values, students are more likely to feel respected, develop curiosity, and build resilience, all of which are crucial for their personal and academic growth. For (2), Senpai Learn believes that providing students with challenging opportunities encourages them to step out of their comfort zones and push their boundaries. This can be achieved by empowering students to take the lead on projects, where mentors offer valuable guidance and support. Additionally, students can be given the chance to present their research and projects at scientific conferences, both locally and internationally. They can also be encouraged to write and submit scientific papers to reputable peer-reviewed journals, allowing them to share their findings with

the broader scientific community. And finally, for (3), the Senpai Learn team provides regular evaluations and timely feedback to facilitate student improvement. This feedback is carefully crafted to promote critical thinking and encourage students to consider problems from multiple perspectives.

Herein, we present the motivations behind the assembly of our unique research team, the careful process in which lead authors surveyed the necessary chemistry education literature to design effective game trials, our initial findings, and key takeaways. We hope this insight will prove useful to other young chemistry students looking to enter the field as well as chemistry educators looking to collaborate with younger students on chemistry education research projects.

Methodology

Assembly of the ChemPOV research team

The aforementioned three student researchers were high school students in the National University of Singapore's specialised high school in STEM and were part of the SCIENTIA programme which encouraged students to pursue a junior research project. As classmates bonded by a shared love for teaching, gaming, and organic chemistry, the student researchers came together as a group under the PARTY approach: Passion, Aspiration, Relationship, Teamwork, Youth (Choo et al., 2024).

They reached out to the corresponding author to take up positions as research trainees in his chemistry education and pedagogy lab, Senpai Learn, with the portfolio of developing and trialling the team's new digital, multiplayer board game, ChemPOV, on young students.

ChemPOV was chosen as it was a game requiring reasoning skill in organic chemistry. From personal observations, the student researchers noticed that learning organic chemistry was an especially challenging task for most of their classmates, having a disproportionately high number of students learning its contents by means of rote learning. This appeared to be correlated with frequent negative attitudes towards the subject. Being passionate about organic chemistry fundamentals, the three student researchers felt strongly about investigating the efficacy of an organic chemistry pedagogical intervention over ones potentially targeting other branches of chemistry.

Once the chemistry education intervention was decided, the student researchers embarked on their maiden voyage in the field of academic research and gained exposure to the workings of a research team. They undertook various tasks and roles as a research trio while working on the project (Table 1).

Table 1: List of roles undertaken in the ChemPOV research project by the student researchers under the supervision of the research mentor.

Role	Description
Administrative	- Coordinate team communication and research planning sessions - Support with administrative processes to ensure compliance with ethical protocols
Content	- Craft organic chemistry reaction schemes - Create organic chemistry Multiple Choice Questions (MCQs) - Vet content material for game
Writing	- Wrote the first draft for conference abstracts for submissions - Wrote the first draft manuscript for publication - Conduct literature review and screen for relevance
Data Analysis	- Develop survey questions and extraction of data - Analyse data and create data visualisations of findings using computer softwares
Communication	- Design and create poster layout to communicate insights - Oral presentation of research findings at international conferences
General	- Feedback and suggestion of improvements to game design and features - Meeting summaries and minutes

The ChemPOV research experience

The student researchers had their initial exposure to research, and their involvement as high schoolers held great significance to the research process. For starters, the environment and method of study between high school and university are vastly different, with the university generally providing greater agency to the learner and teaching courses with content experts. High school has more pedagogically trained teachers where students are more guided across their wide array of subjects. This research experience provided various new perspectives and insights into university for the student researchers and these experiences had the potential to influence their career decisions and university courses.

In particular, designing the first drafts of appropriate MCQs and organic chemistry reaction schemes targeted at university students proved to be significantly daunting for the student researchers during the initial phase of the project. Design of organic chemistry synthesis scheme cards required knowledge of organic reactions typically only covered at the undergraduate level. The student researchers, however, were dedicated and passionate about organic chemistry. Through an aggregation of self-study, engagement with textbooks, online educational resources and in-school Chemistry Olympiad training programmes, the student researchers developed a strong understanding of more advanced undergraduate organic chemistry principles. The synthesis schemes, designed by carefully intertwining a combination of undergraduate organic chemistry topics, proved to be very challenging, especially since no hints were provided. A thorough review of the synthesis schemes designed by the Senpai Learn research team revealed negligible conceptual errors in the schemes, showcasing the firm grasp the student researchers had acquired of the necessary organic chemistry principles utilised in the reaction schemes. Apart from conceptual fundamentals, the student researchers familiarised themselves with tools like ChemDraw to produce the final set of reaction schemes—a valuable skill for a future career in organic chemistry.

The design process for the MCQs brought the student researchers on a different investigative path. The student researchers identified the potential audience for ChemPOV as students exposed to organic chemistry in the Singaporean education system. In this system, students are initially taught organic chemistry in secondary school, through junior college, with further specialisation in university — if students take chemistry-related courses. Naturally, the difficulty level of the MCQs and the core synthetic schemes of ChemPOV were stratified based on the content coverage across these

distinct educational levels.

Reference was taken from the official Ministry of Education coverage across these educational levels (Singapore Examinations and Assessment Board, 2020a, 2020b), as well as undergraduate level pedagogical research (Zoller, 1990; Herron, 1975) in the team's identification of the testable content scope. Given the auxiliary usage of MCQs for ChemPOV, we created questions primarily focused on foundation concepts required for students to understand organic chemistry. Examples include 1) acid and base concepts for understanding reactions mechanisms, 2) nomenclature and skeletal structures to help visualise more complex organic molecules.

Game-based learning: A literature review

To gain a strong theoretical foundation in the game-based learning methodology the Senpai Learn research team was utilising, the student researchers conducted an extensive literature review on the topic.

They began this process with a wide net, first examining the general approaches that exist in chemistry education literature. These included the flipped-classroom approach (Ozdamli & Asiksoy, 2016), gamification of chemistry courses (Da Silva Júnior et al., 2022), peer instruction (Cortright et al., 2005), and game-based learning (Tobias et al., 2013).

In particular, they noted that game-based learning is a widespread methodology used at several other educational institutes and vocation-training environments. This approach leverages gameplay to deliver a fixed set of learning outcomes (Plass et al., 2015). Game-based learning has been empirically shown to have positive learning outcomes, increase student engagement and foster social connection (Shu & Liu, 2019; Romero et al., 2012). A commonly cited attribute of game-based learning is its ability to motivate students. This is delivered through captivating incentive structures, such as inter-player competition, points, and leaderboards, as well as game mechanics that create a high situational interest (Rahimi et al., 2021).

Another closely related reason for adopting game-based learning methodologies is that games offer educators a multifaceted platform to engage their students. The nature of this engagement is closely tied to the design of the game and the environment in which it is implemented (Ruiperez-Valiente et al., 2020). According to previous literature (Plass et al., 2015), these types of engagement include cognitive engagement (i.e., mental processing and metacognition), affective engagement (i.e., emotional processing and regulation), behavioural engagement (i.e., gestures, embodied actions, and movement) as well as sociocultural engagement (i.e., social interactions embedded within a cultural context). The student researchers connected ChemPOV's utilisation of a combination of these engagement methods — from in-game avatars fostering affective engagement to ChemPOV's multiplayer mode bringing sociocultural engagement.

While different educational games utilise varying cocktails of these engagements, all of them are ultimately aimed at fostering cognitive engagement in learners with the learning mechanic delivered through the game (Plass et al., 2015). The student researchers noted at the time that this was an especially important connection to the way ChemPOV was designed, with the primary source of cognitive engagement being the solving of partially filled organic chemistry synthesis schemes.

Furthermore, the use of games as a medium in education also allows instructors to provide an adaptable interface students can interact with. Adaptability in games facilitates learner engagement by means of customisability and personalisation (Hwang et al., 2012). A commonplace strategy most games employ to infuse adaptability into their infrastructure is by including delineated difficulty levels, possibly related to the learners' current level of knowledge or skill level (Plass et al., 2015). This was a key motivating factor for the student researchers to create a new difficulty level, featuring more advanced organic reactions, thereby catering to a wider group of learners.

Lastly, game-based learning offers an opportunity for students to learn without the fear of failure. Rather than being an unwanted outcome, failure is a crucial step in the learning process. In game environments, the repercussions of failure are minimised, encouraging students to take risks and learn from their mistakes (Plass et al., 2015). Flexibility to fail can also foster self-regulated learning, prompting students to adjust their strategies and enhance their conceptual understanding to advance in the game.

ChemPOV research trial on junior high school students

Motivated by the previously reported efficacies of game-based learning, the student researchers sought to bring ChemPOV into the teaching of organic chemistry for younger learners. They decided to conduct a preliminary trial of ChemPOV on their juniors from NUS High School of Mathematics & Science. This was primarily a result of the fruitful SCIENTIA collaboration between the Senpai Learn team and the student researchers — allowing ChemPOV trials to extend beyond the confines of the National University of Singapore. Furthermore, the student demographic suited the research interests of the team, given that students as young as junior high school students have never been given the chance to play ChemPOV with reaction schemes catered to their level of difficulty before.

Additionally, the student researchers noted that when they were first introduced to organic chemistry, many of their peers who disliked 3D-visualisation and the organic chemistry 'language' struggled to absorb it, which motivated them to make the learning experience for their juniors less challenging. As a result, it was decided that the research subjects would be Year 3 (Secondary 3, Grade 9) chemistry students from NUS High School of Mathematics & Science. These students have started learning basic organic chemistry spanning the Singaporean GCE 'O' Level syllabus (Cambridge O Level Chemistry 5070, 2019) for 10th-grade Singaporean students. They have also been introduced to the skeletal

structure representation system. This is left out of GCE 'O' Levels and typically reserved for H2 'A' Levels instead, which are examinations taken by 12th grade Singaporean students. The student researchers split the Year 3 cohort of 176 students into a trial group with 87 students and a control group with 89 students. The trial group was involved in playing ChemPOV while the control group was not provided access to the game in the same time frame. Within the control group, the pre-game survey had 31 responses, while the post-game survey had 82 responses (Figure 1).

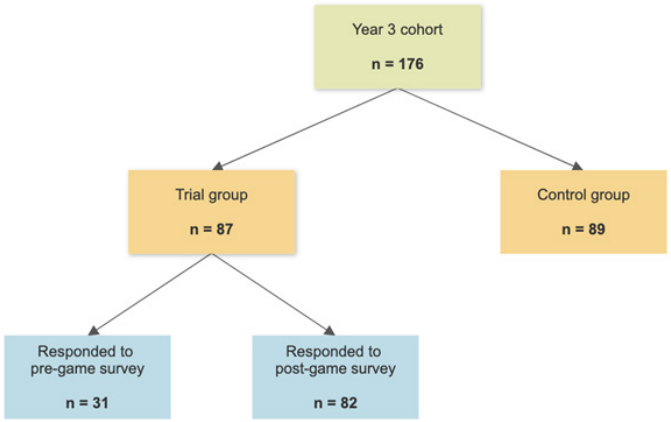

Figure 1: Flowchart illustrating the distribution of students in the trial group versus the control group, and the number of survey respondents within the trial group.

Furthermore, to assess potential shifts in academic performance after playing ChemPOV, the research team administered pre- and post-ChemPOV quizzes to 76 students in the trial group and 76 students in the control group. A total of 24 students did not attempt the quizzes (Figure 2).

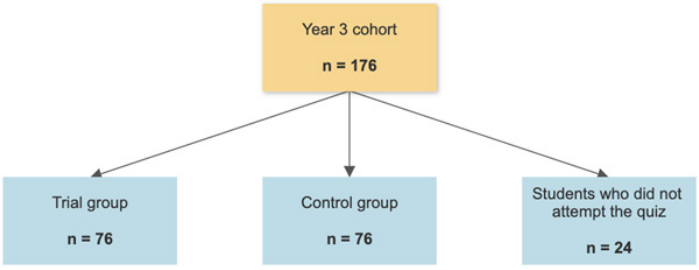

Figure 2: Flowchart illustrating the distribution of students in the trial group versus the control group who attempted both the pre- and post- quizzes administered.

The research team kept to a strict timeframe of milestones to ensure sufficient time between the various tests conducted on the Year 3 students (Table 2).

Measures, including vetting by multiple team members and the chemistry teaching staff at NUS High School, were taken to ensure that the pre- and post- quizzes were of similar standards of difficulty.

Table 2: Timeline of events before, after, and throughout the period of the trial and descriptions pertaining to each event.

Week	Event	Description
Before the trial		
6 months ahead	Pre-Trial	The student researchers gathered and began working on the ChemPOV project together. In collaboration with Senpai Learn, they began crafting synthetic schemes and organic chemistry MCQs for the game's usage.
4.5 months ahead		Administrative paperwork to allow the trial to be conducted on the Year 3 students was completed, alongside meetings with stakeholders and the teaching staff who had to ensure the quizzes and surveys were well-administered.
3 months ahead		The reaction schemes and MCQs were vetted by senior members of the Senpai Learn team and uploaded onto ChemPOV by partners from NUS Information Technology, who assisted Senpai Learn in programming ChemPOV on the back end.
1.5 months ahead		The game was played by the student researchers to ensure their readiness for the actual trial on the large cohort of younger students. The quizzes and surveys were also crafted and finalised during this period.
During the trial		
Week 1	Pre-Quiz	A short pre-quiz consisting of 10 multiple-choice questions was issued to the entire Year 3 cohort (n=176). The purpose of this assessment was to collect data on the students' initial performance in organic chemistry.
Week 2	Pre-Survey	A pre-survey was issued to the participants that would be involved with the game. The purpose of this survey was to gauge the interest of participants in organic chemistry and game-based learning before playing ChemPOV.
Week 3	Game	The research team arranged for a physical engagement session where ChemPOV would be played by the gameplay group in pairs or trios.
Week 4	Post-Survey	A post-survey was issued to the participants involved with the game. The purpose of this survey was to observe any change in attitude or perception of the students towards organic chemistry after playing ChemPOV.
Week 5	Post-Quiz	A short post-quiz consisting of 10 multiple-choice questions was issued to the entire Year 3 cohort (n=176). The purpose of this assessment was to compare their academic performance in organic chemistry before and after playing ChemPOV.
After the trial		
0.5 months after	Post-Trial	The research team compiled all the collected data and began data analysis and representation.
2 months after		The research team submitted the project to SCIENTIA programme's Research Congress, which included a full manuscript, an abstract, and a poster.
3 months after		The research team submitted their first abstract to an overseas conference for poster presentation and was accepted.
1 year after		The research team submitted their first abstract to an overseas conference for oral presentation and was accepted.
1.5 years after		The research team submitted manuscripts to peer-reviewed journals for publication, encompassing the data from the research trial.

Connecting with international chemistry educators about ChemPOV

As part of the holistic research exposure, to provide the student researchers with international experiences, and to encourage them to speak to other researchers about their work, the corresponding author encouraged the student researchers to attend international conferences on chemistry education.

The research team presented posters in the American Chemical Society's Spring Meeting at Indianapolis, USA in 2023, the International Union of Pure and Applied Chemistry's World Chemistry Congress at The Hague, Netherlands in 2023, and presented an oral presentation at the International Conference for Chemistry Education at Pattaya, Thailand in 2024. Their experience as the youngest participants at the IUPAC World Chemistry Congress was also featured in a journal (Kon et al., 2024).

The student researchers gained deep insights from the conversations they held with the experienced researchers at these conferences, had the valuable opportunity to present to numerous audiences from all backgrounds of chemistry, and obtained various takeaways from attending other symposia and conference tracks (Figure 3).

Figure 3: Diagram describing the experiences and personal sharing of each student research member of the ChemPOV team, each at a different conference where ChemPOV was presented to fellow chemists.

Analysis and discussion

Survey results

We display below a correlogram we generated based on our pre-game and post-game surveys (Figure 4). The gradient scale on the far right provides a colour code to the degree of correlation between any two variables, with as faint a colour representing a greatly positive correlation and as dark a colour representing no correlation or slightly negative correlation. The axis labels are described below (Table 3).

Table 3: Description of each axis label.

Axes Label	Description
interest	Interest level towards organic chemistry
engagement	Engagement level during organic chemistry lessons
enjoyment	Enjoyment level during organic chemistry lessons
grades	Personal satisfaction towards chemistry grades
anticipation	Anticipation level towards playing the game again in future (when the reactions have been adjusted to suit their syllabus)
external interest	Frequency of consumption of chemistry-related material beyond school
classmate help	Frequency in approaching fellow peers for assistance towards organic chemistry problems

In Figure 4, the magnitude of the correlation represents the degrees of correlation, with 1.00 or -1.00 indicating perfect correlation while 0 indicates no correlation. The sign (+/-) represents positive/negative correlations. The bottom triangle (in purple) and the upper triangle (in green) represent the pre- and post-survey responses, respectively.

We note that a number of factors surveyed are strongly correlated, with a correlation magnitude exceeding 0.50. Factors that correlate strongly across both surveys as well as the distinction in strongly correlated factor pairs between pre and post surveys are outlined in the table below (Table 4). We also note that there is very limited correlation between

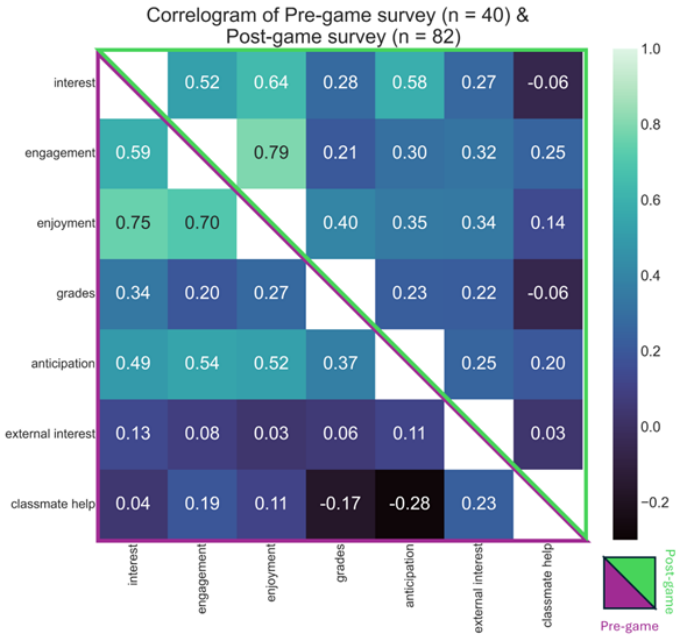

Figure 4: Correlogram displaying a heatmap, with central number within each grid representing the correlation between 2 of the variables obtained from a 5-point Likert-scale question in the pre- and post-ChemPOV survey (interest, engagement, enjoyment, grades, anticipation, external interest, classmate help).

grades, external interest, and classmate help and any of the other variables.

To observe the correlations found in Figure 4 in greater detail, a scatterplot matrix was plotted for each pair of factors from the pre-game and post-game survey data. These plots were coupled with a histogram illustrating distributions of each of these factors for the pre-game and post-game survey. The aggregation of these plots is presented below (Figure 5).

While we did more closely examine the variables which had noticeable changes between the pre- and post- game survey gradients.

Table 4: Summary of observed strong correlations from correlogram, sorted based on similarities and differences between the pre- and post-surveys conducted.

	Pre-Survey	Post-Survey
Shared strong correlations	- Engagement and interest. - Enjoyment and interest. - Enjoyment and engagement.	
Distinctions in strong correlations	- Anticipation and engagement. - Anticipation and enjoyment.	- Anticipation and interest.

Pre-survey and post-survey responses displayed in purple and green respectively.

Quiz results

Score distributions for pre- and post-ChemPOV quiz results for control and trial groups are plotted below (Figure 6). Additionally, the distribution of score differences between the post-ChemPOV quiz and the pre-ChemPOV quiz is

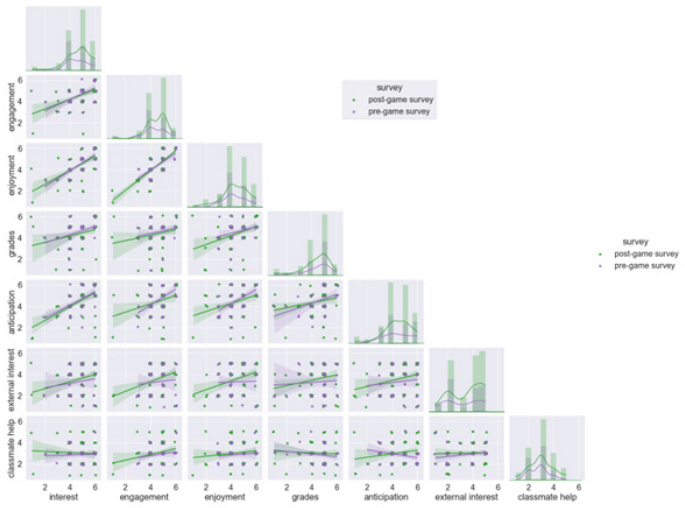

Figure 5: Pairplot (scatterplot matrix) displaying a grid of a) off-diagonal scatter plots, each representing the relationship between 2 of the variables obtained from a 5-point Likert-scale question in the pre-/post- survey (interest, engagement, enjoyment, grades, anticipation, external interest, classmate help). b) on-diagonal histogram and KDE plots for each of the aforementioned variables.

plotted for the trial and control groups. We observe a small right-shift in the distribution of score improvements for the trial group compared to the control group. Furthermore, we found that 59% of students in the trial group showed improved performance in the post-ChemPOV quiz as opposed to 56% in the control group.

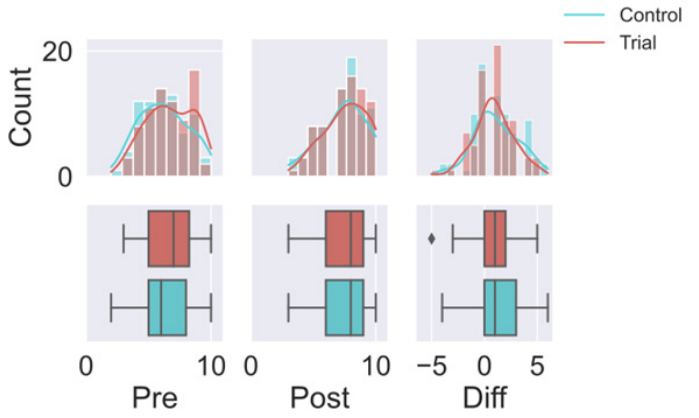

Figure 6: Histogram and boxplots of the pre-test, post-test and change in scores for each individual. (Red: trial group; Blue: control group; Brown: any overlapping area between both groups).

These results indicated to us that, in the context of high school students, academic performance in organic chemistry assessments does not appear to improve significantly after playing ChemPOV once. However, this finding could be confounded by the limited time students had to play ChemPOV as well as the modest two-week time interval between the pre- and post-ChemPOV quizzes.

Conclusions and recommendations

This study outlined the fruitful collaboration between high school students and university researchers. The student researchers, initially driven by their passion for organic chemistry and teaching, found themselves navigating the intricacies of academic research. From the process of crafting MCQs and synthesis scheme problems that challenged undergraduate organic chemistry students to presenting findings at international conferences, these young researchers experienced a steep learning curve that mirrored the very subject they sought to teach—organic chemistry itself.

The international conference experiences were especially transformative for the young researchers. From shifts in public speaking confidence, evolved appreciation for the interconnectedness of distinct chemistry disciplines and the reception of critical feedback from experienced academics, the students' familiarity with the way scientific research is communicated in academia and appreciation for the rigorous standards of academic discourse grew.

A significant outcome of this partnership was the transformation of the student researchers' perspectives on the role of failure in the scientific process. As one team member reflected after the IUPAC World Chemistry Congress, failure in research is not something to "begrudgingly accept, but also to welcome." This shift in mindset, from viewing failure as a setback to seeing it as an integral part of the scientific journey reflects the strength of the "to learn it, do it" principle of applied learning.

The ChemPOV investigative trials conducted by the young researchers, while focusing on a specific cohort of junior high school students, address broader questions about the efficacy of game-based learning in chemistry education. Their results hint at the potential for such interventions to influence student engagement and interest, even if immediate academic gains are not apparent. This suggests the need for longitudinal studies to fully capture the impact of game-based learning tools on students' long-term learning relationship with organic chemistry.

For educators and researchers considering similar collaborations, our experience was made most fruitful by the creation of a supportive working environment that allowed young researchers to take ownership of their work while providing guidance when needed. For meaningful synergies with younger students, we suggest researchers look for the following personality traits: self-disciplined, motivated, receptive to feedback and positive disposition. In our experience, these are the crucial character elements that laid the foundation for a strong and lasting partnership. Our team also observed that these traits are not exclusive to student researchers—much of what would make a productive research alliance with a colleague applies to collaborations with younger students.

During early mentorship phases, we found that having regular weekly meetings kept student researchers engaged and provided an avenue for them to seek regular feedback and grow as scientists. These factors transformed the students'

journey crafting MCQs to presenting at international conferences into one just as much about personal growth as about scientific discovery. This positive research experience has kept the student researchers engaged with the Senpai Learn team's ongoing works, from the development of new chemistry education games to the crafting of manuscripts for journal article submissions, despite being occupied with full-time commitments. Their shared commitment to quality research in organic chemistry education is expected to keep this partnership strong for the foreseeable future.

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Fostering educational innovations in the era of global digital futures with students as partners (SaP) - Agency of university students in the Asian context

Peter Lau[A] A The University of Hong Kong

Kevin Chan[B] B The Hong Kong Polytechnic University

Anna Kwan[C] C Higher Education Research & Development Society of Australasia (HERDSA) Hong Kong Branch

Beatrice Chu[D] D The Hong Kong University of Science and Technology

Paul Lam[E] E The Chinese University of Hong Kong

Theresa Kwong[F] F Hong Kong Baptist University

Crusher Wong[G] G Hong Kong Baptist University

King Chong[H] H Hong Kong Baptist University

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Correspondence

pfmlau@hku.hk [A]

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Abstract

Most studies on Students as Partners (SaP) in the literature have been found to be western-centric, highlighting a significant lack of SaP studies in Asian countries. Higher education in Hong Kong is still developing its SaP practice. This article aims to address this gap by examining how student partnership fosters education innovation in the era of global digital futures, particularly through the *Redesigning Student Learning Experience in Higher Education* (RSLEIHE) project scheme in the recent years in Hong Kong.

Believing that meaningful and impactful student partnership relies on the student agency developed during the projects, this study discusses factors facilitating student agency development through SaP projects of the RSLEIHE scheme in an age of digital futures. The two-stage research design (including student responses on a quantitative survey and a ranking task) allowed for a comprehensive exploration of student perception of student agency levels among a diverse cohort of participants from local universities in Hong Kong.

The findings revealed interesting patterns and variations in student agency across different demographic factors such as gender, level of study and academic disciplines. Notably, graduate students exhibited higher levels of agency compared with undergraduate students, while female students perceived significantly more peer support. Overall, this study emphasises the significance of support systems, trust-building, and opportunities for students to make choices in shaping the student experience.

Introduction

During and after the pandemic, the rapid transition to online and hybrid learning has created opportunities for developing possible usages of technologies in education. The enormous discussions on the role of technologies in shaping future education to prepare students better for their future have led to real innovation in education. A lesson learned at the time is that such a global challenge requires collaborative efforts among the major stakeholders: teachers and students.

The *Redesigning Student Learning Experience in Higher Education* (RSLEIHE), a Students as Partners (SaP) scheme spearheaded by The Higher Education Research and Development Society of Australasia (HERDSA) Hong Kong Branch in 2017, stands as a distinguished endeavour aimed at fostering student-centric, student-driven, and forward-looking learning and teaching paradigms to captivate student engagement and bolster their capacities in Hong Kong higher education. Over the years, 50-plus projects under the RSLEIHE scheme involved using technologies to enhance teaching and learning. Particularly in 2021, all 16 projects were fully conducted online due to the COVID-19 pandemic. In terms of project nature, around 38% involved providing online learning platforms to support peer student learning, 25% involved online teaching to deepen and widen learning, 25% involved initiating digital interventions in a course such as using gamification, and 13% involved investigating and improving online teaching (Kwan et al., 2022).

In addition to the group projects, the scheme encompasses project development, awards, a symposium, and a publication showcasing the group project outcomes. For example, in 2021, with *Learning in the era of "New Normal": Post-Pandemic Learning* as the main theme, the RSLEIHE scheme recruitment opened to all teachers and students in local higher education institutions and was promoted through their teaching and learning centres. Adhering to a student-teacher collaborative model that requires each project team to include a minimum of two students and one academic or professional staff member, students were encouraged to voice out their learning needs and co-create teaching and learning projects with their teachers. The projects targeted to engage and empower students and directly meet their future needs in one of the five subthemes, including (1) Pedagogical Change during the Pandemic, (2) Alternative Assessment, (3) Holistic Competencies, (4) Educational Innovations, and (5) Digital Learning Strategies. These themes highlight the significant challenges in the era of post-pandemic learning, which emphasises the transition to hybrid learning environments for both students and teachers with digital learning and teaching strategies. Twenty-two proposals were reviewed by EdTech experts, education developers/research and educational leaders. Seventeen projects were selected and received feedback from the review panel for further project development. Eventually, sixteen project teams completed execution, implementation and evaluation by May 2021 and reported in the online RSLEIHE symposium in June 2021. As a follow-up engagement, a collaborative publication on the completed projects were edited and published on the HERDSA HK website (https://herdsahk.edublogs.org) in the next year.

Organised biennially, the RSLEIHE scheme consisted of three distinguished awards and three to six merit awards, underscoring a commitment to recognising excellence. With the participation of local universities in Hong Kong (including the Chinese University of Hong Kong, City University of Hong Kong, Hong Kong Baptist University, the Education University of Hong Kong, Lingnan University, Hong Kong Polytechnic University, the Hong Kong University of Science and Technology, the University of Hong Kong, Hong Kong Metropolitan University, and Hong Kong Institute of Vocational Education), the scheme has successfully culminated in over 50 SaP projects. Over 700 individuals partook in the symposia, leading to four online publications. The outcomes of the scheme showed that, despite constraints in the education system such as power relations, SaP projects created opportunities for students to discuss pedagogies with teachers and to develop student agency. The transformative power of such initiatives is demonstrated by occasions when students can make choices and take actions that affect their learning experience. This capacity enriches their educational journey and nurtures a profound sense of agency and ownership in their academic pursuits. This sense of empowerment extends beyond the classroom, equipping students with the skills and mindset needed to navigate the realms of academia, and the workplace and positively impact society. By fostering independence and ownership, these initiatives lay a strong foundation for students to excel in their future endeavours and contribute meaningfully to various aspects of their lives and communities. It showcased student agency in SaP projects from multiple perspectives.

Most studies on SaP in the literature were found to focus on Anglophone countries, and there is currently a dearth of SaP studies in other regions (Dai et al., 2024). Higher education in Asia is still developing its SaP practice (Liang & Matthews, 2020). Confucianism is generally believed to exert significant cultural influence on the educational systems of Asian countries. The Confucian cultural norms of revering teachers and embodying humility and politeness promote the notion that students should be instilled with respect, attentiveness, and obedience from a young age, rather than fostering a spirit of inquiry. This creates a power imbalance between teachers and students, with the teacher exercising authority over decision-making, while students stay passive and compliant in a rigid school setting (Liang & Matthews, 2020). This cultural context poses a hurdle in implementing SaP, which emphasises student-centredness in Asia universities.

A group of Hong Kong scholars, Zou et al. (2023), though did not find a prominent influence of Confucian background in three SaP projects in a Hong Kong university. They suggested that the cultural factors (such as honouring respect and obedience to authorities) might affect students approaching student-staff partnership because students cannot "immediately assume a partner's role" (p. 15) at the project's initial stage. Such uncertainty and hesitation might indicate limited opportunities to develop student agency. Yang et al. (2023) also assert that student agency is not taken for granted in Asian universities. Moreover, studies on the factors that support student agency development in

SaP projects, particularly in the Asia context are few and far between. It is the fact that SaP studies in the literatures are generally western-centric (for example, the US, Europe and Australia, etc.). There are only a few Asian studies on SaP and hence less voices representing the Asian culture. This study aims to fill this gap by focusing on two key questions:

1. To what extent do students develop student agency through student partner projects in the era of global digital futures?

2. What are the factors that facilitate student agency development in Hong Kong higher education from student perspectives?

Literature review

Students as partners

The core theme of the RSLEIHE scheme, the Student as Partners (SaP) approach has been gaining global recognition for its transformative impacts on various aspects of higher education. SaP is "a collaborative, reciprocal process" of teaching and learning whereby "all participants have the opportunity to contribute equally, although not necessarily in the same ways, to curricular or pedagogical conceptualisation, decision making, implementation, investigation, or analysis" (Cook-Sather et al., 2014, pp. 6-7). This collaborative framework is known for producing positive outcomes in student learning, faculty development, curriculum innovation, and the scholarship of teaching and learning by engaging students as partners in teaching and learning, which recognises students' contributions to shaping educational practice (Cook-Sather & Matthews, 2021). By fostering a reciprocal process where students and other stakeholders, including university administrators, faculty members, student affairs staff, alumni, and community/industry representatives, work together to shape curricular and pedagogical practices, the approach provides opportunities for students to develop student agency (see the following Student agency section).

Cook-Sather and colleagues (2014) emphasised the significance of empowering students to drive meaningful development in teaching and learning. This ethos of collaboration and shared responsibility within higher education has been described as transformational (Judd et al., 2021), highlighting its potential to revolutionise traditional educational paradigms. An affirmative partnership with students prompts teachers to question the assumptions they made about the teaching and learning process "in a way we (teachers) don't often make explicit" (Flint, 2015, p. 2) and identifies any presumptions in educational quality enhancement. Involving students in curriculum development empowers them as active participants in their educational journey and enhances their ownership of learning, deepens their understanding of educational processes, strengthens their professional identity formation, and builds rapport among stakeholders.

The SaP approach enhances higher education by integrating theory with practice and fostering a culture of mutual respect, trust, and collaboration, particularly during the transition to online and hybrid learning, which has revealed technology's potential to revolutionise educational practices. This transition not only provided an impetus for the integration of digital tools but also highlighted the critical importance of collaboration among all stakeholders, including teachers and students. One significant observation from this period is that students often exhibited a higher proficiency in utilising various e-tools, showcasing their IT and digital literacy skills. These newfound dynamic allowed teachers to leverage student expertise, fostering a collaborative environment where students could actively contribute to teaching innovations.

Many researchers (for example, Curran, 2017; Dickerson et al., 2016; Hill et al., 2019; Luke & Evans, 2021), identified the benefits of involving student partners as pedagogical co-designers or co-researchers in developing educational (or pedagogy-driven) technologies, for example, gained access to diverse perspectives and marginalised voices for innovative applications, improved student engagement, personalisation of learning, and enhanced dialogue between teachers and students in a digital world. These researchers identified the need to adopt SaP model in the future EdTech research and potential impacts on teaching and learning.

This inclusive and participatory model enriches the educational experience for students and drives continuous innovation and evolution in teaching and learning methodologies within the academic community. Embracing this collaborative ethos establishes a culture of shared responsibility and co-creation, ultimately creating a transformative educational experience for all participants involved (Peseta et al., 2021).

Student agency

For a meaningful and productive student-staff partnership, Jääskelä and colleagues (2017) proposed that it relies on the student agency developed or fostered during the partnership project. According to Bandura (1999), agency is entangled with personal intents and self-processes like motivation and self-efficacy, acting as a mediator between thinking and action. Student agency refers to the ability of students to take an active role in their learning and to have a sense of control over their educational experiences. According to the Organisation for Economic Co-operation and Development (Organisation for Economic Co-operation and Development, 2019, p. 2), it also covers the ability to "set goals, reflect, and act responsibly to effect change". In higher education, it is about students' active involvement, rather than "passive acceptance" (p. 2); shaping the surroundings, rather than being shaped by others; willing to take risks for the decisions/choices that they have made, instead of accepting the decision made by others. It is anticipated that when students develop agency, meaning that they can choose the content and pathway of their education, they are more likely to demonstrate increased motivation towards learning and set goals for themselves. In brief, it refers to a student's belief and ability to explore resources and take control of their academic journey. This also depends on the resources or supports (in *individual, relational* and *contextual/situational* domains) that students need to engage purposefully, intentionally, and meaningfully in their

learning experiences within educational settings (Jääskelä et al., 2017).

By providing students with decision-making and participation opportunities, they can take on a more proactive role in their learning experiences. Students with strong agency are more likely to assume accountability for their learning objectives and methods, promoting self-improvement and personal growth.

In higher education, some argue that curriculum transformation necessitates strong ecological support, with learners' proactive attitude crucial for success (Luong et al., 2023, Peseta et al., 2021). Active student involvement is vital for a smooth transition to university life: students adapt to new academic standards, acquire skills for independent academic journeys, cultivate new perspectives, knowledge, and capabilities, develop strategies for engaging with university faculty, and integrate into professional communities. By fostering student agency within student-staff partnerships, a more positive and meaningful learning environment can be cultivated, ultimately enhancing the quality of education. Therefore, student agency is considered an integral component in fuelling successful student-staff collaboration (or SaP ventures) among all teaching and learning centres in Hong Kong universities.

To assess student agency, Jääskelä and colleagues (2017) developed the "Agency of University Student (AUS) Scale" of three resource domains (*individual, relational,* and *contextual*). AUS is a student self-report instrument consisting of 54 items (see Appendix). These items are found to be correlated positively with ten factors across the *individual, relational,* and *contextual* domains: Interest and Motivation (including utility value), Self-efficacy, Competence Beliefs, Participation Activities; Equal Treatment, Teacher Support, Peer Support, Trust; and Opportunities to Influence, and Opportunities to Make Choices.

In a student partnership project or setting, Individual Resources (consisting of four factors including Interest and Motivation, Self-efficacy, Competence Beliefs, Participation Activities) represent a range of personal readiness that an individual would consider. When students feel interested in the project content, identify with the values of the project (utility), predict enjoyment, have a strong belief in their abilities to succeed and feel confident to participate, they are more likely to engage in the partnership project.

Relational Resources include how an individual perceives emotional and interpersonal support from teachers and peers, and the perceived working relationship with others. It also includes the perception of how others value an individual's contributions or respect his/her options. Four factors - Equal Treatment, Teacher Support, Peer Support, and Trust, contribute to the above-mentioned support needs, and hence foster student agency. Students who feel supported in these factors are more likely to demonstrate agency.

In the Contextual Resources, providing students with opportunities to influence and make choices is paramount in cultivating student agency. While the first two dimensions focus on the support at a micro level (working level), the Contextual dimension focuses on the support from the department or university at a macro level. It concerns whether the university or education systems establish relevant regulations or policies to offer opportunities for student partnership and co-creation to influence the teaching and learning environment or "ecosystem". Other concerns about this dimension consist of departmental acknowledgment and university recognition for students' contribution to and participation in SaP projects although these items have yet been included in the existing AUS scale. With these types of support, students feel that their voices will be heard, and their contributions will be valued. It conveys messages to students that the universities welcome them to explore solutions to the existing challenges in teaching and learning. More importantly, universities are willing to involve students as partners in decision-making.

The AUS scale helps faculty members to assess the experience and capacity of student agencies and allows academic developers to investigate what resources are (not) in place to support the development of student partnership projects.

Although the AUS scale was established within the Finnish context, it encompasses ten factors across individual, relational, and contextual domains, which sound reasonably similar in Asian context. The scale offers a complete framework for assessing student agency, hence rendering it a powerful tool applicable to students globally. Its versatile character guarantees efficient application in many educational environments. This study employed the scale to examine elements that facilitate the development of student agency in SaP projects within an Asian context, as pertinent research in this region is few.

Methods

The research method employed in this study followed a two-stage design to first understand students' experience when they were engaged as student partners in projects in Hong Kong universities and second to identify the factors or resources that support the development of student agency from student perspectives.

The first stage entailed administering the AUS scale (Jääskelä, et al., 2017) to collect students' perceptions after the SaP projects or student-faculty collaboration. A five-point Likert scale is used, with 1 as "Strongly Agree" and 5 as "Strongly Disagree". The data collection, conducted online via the Qualtrics platform in 2023, engaged a diverse cohort of 231 respondents from Hong Kong local universities. Undergraduate and postgraduate students who were involved in SaP projects or student-faculty collaboration were the target groups. They were recruited by snowball sampling through teaching and learning centres at local universities.

In the study, t-tests were utilised to compare the mean scores of the 54 items across different demographic dichotomies, such as gender, level of study (undergraduate versus postgraduate), and STEM versus non-STEM major. This

statistical test aimed to identify any significant differences in the levels of student agency among the demographic dichotomies.

A confirmatory factor analysis (CFA) was conducted to thoroughly examine the factorial structure and validate the AUS within the unique context of Asian higher education. Utilising Onyx, an open-source tool for structural equation modelling (SEM), maximum likelihood (ML) estimation was employed to evaluate the model parameters (von Oertzen et al., 2015). Model fit was assessed using various indices, including the chi-square test, Comparative Fit Index (CFI), Standardised Root-Mean-Square Residual (SRMR), and Root-Mean-Square Error of Approximation (RMSEA), to ensure a robust assessment of the model fit.

In the second stage of the study, the participants were further invited to rank the 10 AUS factors according to their experience. Among the 231 students, 45 accepted the invitation. Their responses were collected for descriptive analysis.

Data analysis and discussion

Student agency perceived in SaP projects

In the first stage, this study encompassed a total of 231 university students in Hong Kong comprising 162 undergraduate (UG) students and 69 research postgraduate (RPG) students, with a gender distribution of 144 females and 87 males. Most of our respondents were female, constituting 62% of the sample, while undergraduate students comprised 70.1% of the participant pool (see Table 1).

Table 1. Gender and level of study.

		Education Level		Total
		Undergraduate	Postgraduate	
Gender	Male	61	26	87 (37.7%)
	Female	101	43	144 (62.3%)
Total		162 (70.1%)	69 (29.9%)	231 (100%)

Figure 1 shows the overall ratings in three dimensions. Overall, participants perceived more support from Individual and Relational Resources. The mean scores are 2.25 and 2.26 out of 5 (where 1 represents "Strongly agree"). However, they experienced less support from Contextual Resources (the mean score is 2.53). A similar pattern was also observed in genders and levels of study. This pattern suggests that Hong Kong university students in general perceived more support from their peers and teachers but less support from the department or university during their SaP engagement. Opportunities to Make Choices and Opportunities to Influence are two factors of Contextual dimension resources, so this might also imply that opportunities for students to make decisions in pedagogical design and influence teaching and learning experience are limited in Hong Kong university curricula.

Compared with undergraduate students, research postgraduate students rated more positively in nine of the ten AUS factors, highlighting a higher level of student agency perceived. Table 2 summarises the descriptive statistics for levels of study. Significant differences were identified between UG and PG students, in all factors, except the Peer Support. This suggests that the PG students generally experienced more resource support regarding the nine factors of the AUS scale.

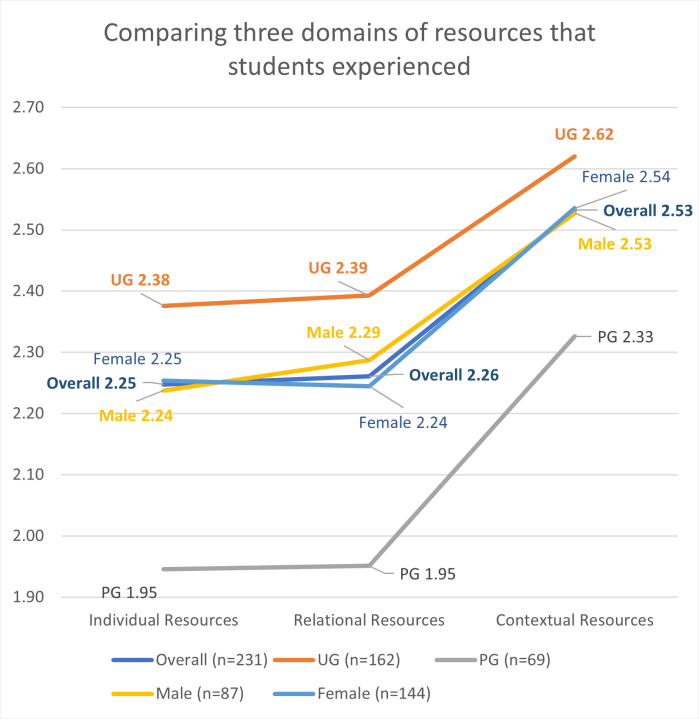

Figure 1. Comparing three domains of resources that students experienced.

Table 2. Descriptive statistics for levels of study.

Measure	Undergraduate		Postgraduate		F (1, 229)
	M	SD	M	SD	
AUS_L01_Make Choice	2.63	0.67	2.29	0.75	11.40***
AUS_L02_Equal Treatment	2.61	0.52	2.32	0.65	12.65***
AUS_L03_Participation	2.27	0.61	1.93	0.55	14.76***
AUS_L04_Motivation	2.45	0.47	2.20	0.53	12.75***
AUS_L05_Self Efficacy	2.26	0.70	1.67	0.67	35.83***
AUS_L06_Competence	2.65	0.40	2.28	0.59	30.37***
AUS_L07_Teacher Support	2.62	0.75	1.95	0.96	32.47***
AUS_L08_Peer Support	2.23	0.66	1.91	0.79	10.26
AUS_L09_Trust	2.11	0.61	1.62	0.61	30.69***
AUS_L10_Influence	2.61	0.41	2.36	0.58	14.22***

***$p < .001$

1 = Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly Disagree

Contrasting to the level of study, Table 3 shows that gender disparities were evident specifically in the Peer Support factor, with female students (M = 2.06, SD = .696) reporting significantly more support in this factor, F (1, 229) = 4.421, p = .037. It is in line with the research conducted by Colarossi and Eccles (2000). This gender difference may reflect significant and widespread variations in how males and females experience and understand working relationships with others at both social and personal levels (Gilligan, 1993). However, in contrast to the findings of Jääskelä et al. (2017) regarding gender differences in the AUS factors, the t-test demonstrated substantial differences in the Interest and Motivation factor, with Finnish female students reporting higher levels than their male counterparts. This interesting differences between Finnish and Hong Kong female students' perceptions would deserve further investigation.

Table 3. Descriptive statistics for gender.

Measure	Male		Female		F (1, 229)
	M	SD	M	SD	
AUS_L01_Make Choice	2.53	0.72	2.52	0.70	0.02
AUS_L02_Equal Treatment	2.49	0.60	2.53	0.57	0.39
AUS_L03_Participation	2.16	0.62	2.17	0.61	0.01
AUS_L04_Motivation	2.36	0.48	2.38	0.51	0.09
AUS_L05_Self Efficacy	2.06	0.68	2.10	0.78	0.16
AUS_L06_Competence	2.55	0.49	2.53	0.50	0.03
AUS_L07_Teacher Support	2.40	0.85	2.44	0.88	0.14
AUS_L08_Peer Support	2.26	0.72	2.06	0.70	4.42*
AUS_L09_Trust	1.99	0.63	1.94	0.66	0.46
AUS_L10_Influence	2.52	0.41	2.55	0.52	0.19

*$p < .05$

1 = Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly Disagree

When comparing disciplinary differences between STEM and non-STEM majors, no significant differences were observed across all 10 AUS factors, suggesting that the AUS model might be applicable across diverse academic disciplines (Table 4).

Table 4. Descriptive statistics for STEM & Non-STEM students.

Measure	STEM		Business/Humanities/ Social Sciences		F (1, 229)
	M	SD	M	SD	
AUS_L01_Make Choice	2.55	0.68	2.47	0.76	0.68
AUS_L02_Equal Treatment	2.52	0.53	2.52	0.68	0.00
AUS_L03_Participation	2.20	0.55	2.10	0.74	1.24
AUS_L04_Motivation	2.38	0.46	2.37	0.59	0.03
AUS_L05_Self Efficacy	2.14	0.65	1.96	0.91	2.84
AUS_L06_Competence	2.57	0.44	2.46	0.60	2.51
AUS_L07_Teacher Support	2.49	0.81	2.27	0.99	2.96
AUS_L08_Peer Support	2.18	0.69	2.05	0.76	1.53
AUS_L09_Trust	2.01	0.61	1.85	0.74	2.79
AUS_L10_Influence	2.55	0.42	2.51	0.60	0.26

1 = Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; 5 = Strongly Disagree

The study encountered challenges in achieving a satisfactory model fit. In this study, the AUS model exhibited poor fit across all items, as evidenced by the statistical results ($\chi 2$ (64, N = 231) = 4272.41, $p < 0.001$, CFI = 0.672, SRMR = 0.376, RMSEA = 0.093). The factor loadings of the final CFA were based on 54 items, and the CFA results of the 10 factors are presented in Table 2. One of the possible reasons for this could be attributed to the negatively worded items necessitating data reversal. All negatively worded items revealed low factor loadings at 0.6 or lower, except in the Teacher Support (AUS_037, AUS_038, AUS_039), underscoring a lack of alignment with the corresponding AUS dimensions. In the context of language and the Asian perspective, the adaptation of the AUS model to better suit an Asian environment holds significant implications. By rephrasing negative items into positive equivalents or removing them, researchers can tailor the model to align more closely with the cultural nuances and communication patterns prevalent in Chinese language and logistics contexts. This adjustment could facilitate a more accurate assessment of student agency within the specific socio-cultural framework of Asia, offering insights that are more relevant and applicable to the educational and logistical dynamics.

Overall, the feedback provided by respondents in the study revealed a trend of lower ratings in the dimensions related to opportunities to make choices and equal treatment within the AUS model. Conversely, respondents expressed higher levels of satisfaction and positive perceptions in factors such as teacher support, trust, and opportunities to influence. These contrasting ratings shed light on the varying priorities and experiences of individuals within the educational context, emphasising the significance of support systems, trust-building, and avenues for meaningful impact in shaping the student experience.

Table 5. Confirmatory Factor Analysis results.

Item	Factor	R^2	Item	Factor	R^2
AUS_001 #	AUS_L01_Make Choice	0.568	AUS_028	AUS_L06_Competence	0.878
AUS_002	AUS_L01_Make Choice	0.878	AUS_029	AUS_L06_Competence	0.852
AUS_003	AUS_L01_Make Choice	0.807	AUS_030	AUS_L06_Competence	0.866
AUS_004	AUS_L02_Equal Treatment	0.687	AUS_031 #	AUS_L06_Competence	0.487
AUS_005 #	AUS_L02_Equal Treatment	0.430	AUS_032 #	AUS_L06_Competence	0.496
AUS_006	AUS_L02_Equal Treatment	0.705	AUS_033 #	AUS_L06_Competence	0.470
AUS_007	AUS_L03_Participation	0.856	AUS_034	AUS_L06_Competence	0.606
AUS_008	AUS_L03_Participation	0.859	AUS_035 #	AUS_L07_Teacher Support	0.584
AUS_009	AUS_L03_Participation	0.849	AUS_036	AUS_L07_Teacher Support	0.748
AUS_010	AUS_L03_Participation	0.741	AUS_037 #	AUS_L07_Teacher Support	0.659
AUS_011	AUS_L03_Participation	0.820	AUS_038 #	AUS_L07_Teacher Support	0.622
AUS_012	AUS_L03_Participation	0.718	AUS_039 #	AUS_L07_Teacher Support	0.666
AUS_013 #	AUS_L03_Participation	0.469	AUS_040	AUS_L08_Peer Support	0.829
AUS_014	AUS_L03_Participation	0.682	AUS_041	AUS_L08_Peer Support	0.831
AUS_015	AUS_L03_Participation	0.686	AUS_042	AUS_L08_Peer Support	0.789
AUS_016 #	AUS_L04_Motivation	0.586	AUS_043	AUS_L09_Trust	0.812
AUS_017	AUS_L04_Motivation	0.773	AUS_044	AUS_L09_Trust	0.856
AUS_018 #	AUS_L04_Motivation	0.552	AUS_045	AUS_L09_Trust	0.853
AUS_019	AUS_L04_Motivation	0.805	AUS_046	AUS_L09_Trust	0.902
AUS_020	AUS_L04_Motivation	0.804	AUS_047	AUS_L09_Trust	0.731
AUS_021	AUS_L04_Motivation	0.821	AUS_048	AUS_L09_Trust	0.803
AUS_022	AUS_L04_Motivation	0.802	AUS_049	AUS_L09_Trust	0.800
AUS_023	AUS_L05_Self Efficacy	0.885	AUS_050	AUS_L10_Influence	0.943
AUS_024	AUS_L05_Self Efficacy	0.833	AUS_051	AUS_L10_Influence	0.940
AUS_025	AUS_L05_Self Efficacy	0.870	AUS_052 #	AUS_L10_Influence	0.443
AUS_026	AUS_L05_Self Efficacy	0.849	AUS_053	AUS_L10_Influence	0.789
AUS_027	AUS_L05_Self Efficacy	0.830	AUS_054 #	AUS_L10_Influence	0.476

Reversed-coded item

The interconnectedness between the Trust and Peer Support factors can indeed be discerned through data analysis. It shows that when students trust their teachers and peers, it can foster a sense of camaraderie, collaboration, and mutual respect within the project, r (229) = .616, $p < .001$. Also, students reported that they rarely experienced or articulated Contextual Resources in SaP projects. In the AUS scale, Contextual Resources involve the importance of two key factors: Opportunities to Influence and Opportunities to Make Choices. The former refers to what extent students can share their viewpoints to influence the curriculum design. It emphasises the significance of shaping their learning experiences and giving voices in determining the direction of their studies. Opportunities to Make Choices encompassed the sense of control of their learning progress, and the flexibility to choose from various pathways based on individual needs/backgrounds. Evaluating and enhancing the mechanisms through which students can access and leverage Contextual Resources within SaP projects is important. By fostering a culture that values student agency, choice, and engagement, a more personalised and enriching educational environment can be created in SaP projects.

Factors facilitating student agency in Hong Kong higher education: Student perspectives

In the second stage of the study, 45 students (including 20 UG and 25 PG students who participated in the first stage of the study) accepted the invitation to rank three most important factors among the 10 factors of the AUS scale. Figure 2 shows the factors ranked by students (top three factors). It was

suggested that Hong Kong students displayed a tendency to prioritise Individual Resources, particularly focusing on considering aspects like personal interest, motivation, and competence beliefs, before identifying support from peers or teachers (Relational Resources), and finally department or university support (Contextual Resources). This emphasis on personal drive and self-perceived abilities underscores the proactive nature of these students in managing their academic endeavours. Additionally, it demonstrates how participants in Hong Kong universities displayed a blend of neoliberal, Mainland Chinese, and Western influences. It was demonstrated by the desire of SaP to maximise personal gains while still adhering to directions from teachers (Liang et al., 2024). This also explains why, the top three factors ranked by the participants among the 10 AUS factors are the Interest and Motivation, Competence Beliefs, and Trust factors. The top two belong to the Individual domain, while the third-ranked factor, Trust, is one of the Relational Resources.

According to Ryan and Deci (2017, 2024), Self-Determination Theory (SDT) posits that the fulfilment of three fundamental psychological needs—Autonomy, Relatedness, and Competence—is crucial for fostering well-being and motivation in various social contexts. In this regard, the two AUS factors (Interest and Motivation and Competence Beliefs) seem to support the needs for Autonomy and Competence in SDT. On the other hand, Trust factor in the AUS fosters a supportive learning environment with peers that also satisfies the needs for Relatedness in SDT.

The two factors in the Contextual dimension were generally ranked lower. By comparing the findings in Stages One and Two, it seems that students were less aware of Contextual Resources, thus might overlook the impact of these resources. Their overlook could be due to their less exposure to the supports in the Contextual dimension.

However, compared with Opportunities to Influence, Opportunities to Make Choices factor seems to be more important in this dimension, suggesting that students tended to agree that making choices or the sense of control of their learning is more important than the influence on curriculum development.

Interest and motivation play a crucial role in students' decision to participate and engage in SaP projects. Students require sufficient motivation, typically driven by topics that pique their interest, to actively engage in SaP projects. They also seek to develop Competence Beliefs and expect to be inspired and gain insights from the projects. Simultaneously, Competence Beliefs were ranked as the second most important dimension by students. Moreover, students also aspire to be equally treated by teachers in projects. This indicates students' strong need for emotional support from teachers in SaP projects, creating a sense of safety and the desire for fair treatment from teachers. The quality of teacher-student interactions and the establishment of a tolerant and emotionally secure atmosphere have a significant impact on fostering student agency (Jääskelä et al., 2020).

Apart from the Equal Treatment factor, the Trust factor is considered more important than the other two factors (Peer Support and Teacher Support). Based on the description of the items, these two factors are more action-based, while the Trust factor is more related to the feeling of welcome, encouragement, and the perception of collaboration and approachability in a project. To do this, teachers must facilitate interaction with students, provide students with the guidance they need, demonstrate a sincere interest in students' viewpoints, and use tools to gather and compile information about their experiences with their agency and learning environments (Jääskelä et al., 2020). When teachers create an environment where students feel respected, supported, and valued, and where they believe that teachers and the university have their best interests at heart, students are more likely to trust in their teachers and the SaP project as a whole (Mitchell et al., 2018). When students feel that their perspectives are acknowledged and respected, they are more inclined to engage actively in their studies, collaborate with their teachers and classmates, and take ownership of their learning journey.

Overall, it appears that Contextual Resources are ranked lower. However, within this dimension, the ranking of Opportunities to Make Choices is similar to that of Self-efficacy factor in the individual domain and even higher than peer support and teacher support in Relational Resources. This indicates that students desire the opportunity to autonomously choose how they complete activities more than the opportunities to influence, for example, course structure and contents. They wish to have the autonomy to make decisions during activities, enabling them to fully contribute and be prepared to learn from their experience and mistakes. This pursuit of autonomy reflects students' desire for engagement and a sense of responsibility in their learning process, while also highlighting their emphasis on personal growth and development. Hence, in SaP projects, it is advisable to offer students a variety of choices and autonomy in decision-making. By providing students with the opportunity to make choices and have a say in their participation, they are empowered to take charge of their learning journey. This increased level of sense of agency can lead to heightened motivation, active engagement, and a stronger sense of responsibility among students as they navigate their educational endeavours.

Suggestions for implementation and further research

The contrasting ratings obtained from this study can shed light on the varying priorities and experiences of individuals within the educational setting, emphasising the significance of robust support systems, trust-building measures, and opportunities for students to make decisions and meaningful contributions. To improve students' trust and agency, teachers are encouraged to actively foster interactions with students, offer essential guidance, and exhibit authentic concern for their viewpoints, while simultaneously cultivating an environment where students feel respected and valued, thereby ensuring that students believe that teachers and the institution consistently prioritise their best interests. This can markedly enhance students' confidence in teachers and the whole SaP project. Furthermore, evaluating and enhancing

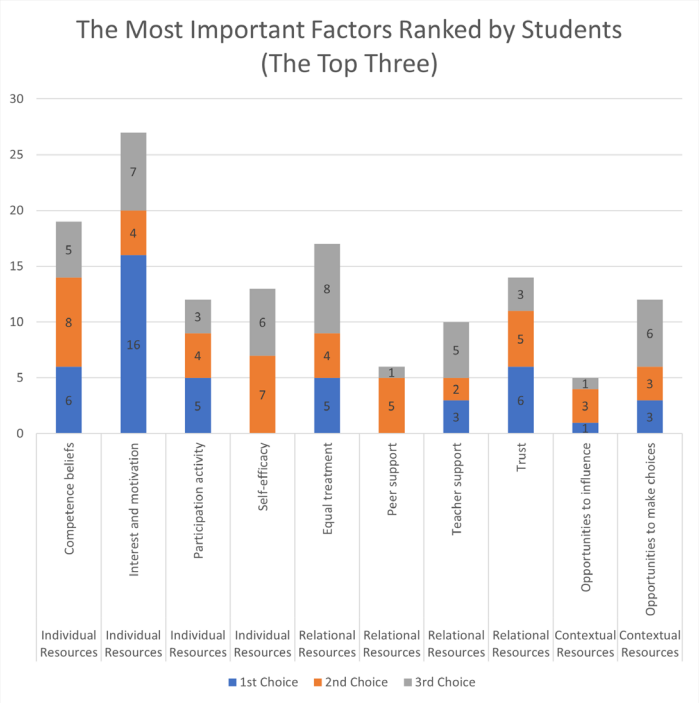

Figure 2. The top three factors ranked by students.

the mechanisms through which students can access and leverage Contextual Resources within SaP projects is important. By fostering a culture that values student agency, choice, and engagement, a more personalised and enriching educational environment can be created in SaP projects.

A practical suggestion for further research the Hong Kong context is to adapt the AUS scale and items by rephrasing negative items into positive equivalents. This adjustment would allow the model to align more closely with the cultural nuances and communication styles prevalent in Chinese language and logistics contexts, facilitating a more accurate assessment of student agency within the specific socio-cultural framework of Asia. With a modified AUS scale for Hong Kong or Asian students, it is believed that any differences between groups (such as gender, levels of study and discipline) could be explained in more details.

Conclusions

In conclusion, this study has provided valuable insights into the concept of student agency within the Asian context in an age of digital futures, particularly focusing on SaP projects and student-faculty collaborations addressing themes such as pedagogical change during the pandemic, alternative assessment, and educational innovation, utilising digital learning and teaching strategies. The two-stage research design allowed for a comprehensive exploration of student perception of student agency levels among a diverse cohort of participants from local universities in Hong Kong.

The findings revealed interesting patterns and variations in student agency across different demographic factors such as gender, level of study and academic disciplines. Notably, graduate students exhibited higher levels of agency compared with undergraduate students, and female students perceived significantly more peer support. The study also highlighted the importance of trust, teacher support, and opportunities for students to influence their educational experiences in fostering student agency.

In the context of advancing student engagement and empowerment within higher education in an age of digital futures, particularly through SaP projects, it is crucial to explore effective strategies and practices that can enhance the overall student experience. Recognising the importance of contextual resources and cultural sensitivity can lead to more impactful educational initiatives that resonate with the diverse needs of students. To effectively evaluate and enhance the mechanisms through which students can access and leverage contextual resources within SaP projects, it is essential to foster a culture that prioritises student agency, choice, and engagement, ultimately creating a more personalised and enriching educational environment.

Overall, the study underscores the significance of support systems, trust-building, and opportunities for students to make choices in shaping the student experience. By prioritising Individual Resources (including interest, motivation, and competence beliefs, etc.,) students in Hong Kong demonstrated a proactive approach to managing their academic endeavours in SaP projects. This study acknowledges certain limitations, including a relatively low response rate and concerns regarding the overall quality of the data collected. Furthermore, the structure of the five-point Likert scale, where a rating of 1 corresponds to "Strongly Agree" and a rating of 5 indicates "Strongly Disagree," may contribute to some confusion among respondents. This configuration can be perceived as counterintuitive, potentially impacting the clarity of participants' responses.

Moving forward, further research and adaptation of the AUS model to suit the Asian environment are essential for promoting a more personalised and enriching educational environment that empowers students to actively engage and take ownership of their learning journey, while addressing potential differences related to gender and age. This study lays a foundation for future exploration and enhancement of student agency within the unique context of Asian higher education.

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Appendix

Agency of University Student (AUS) Scale

Items

AUS_L01 Opportunities to Make Choices

AUS_001. No possibility to choose between various ways of completing the course #

AUS_002. Possibility to choose the way to complete the course

AUS_003. Possibility to take a stand on working methods used in the course

AUS_L02 Equal Treatment

AUS_004. Equality among students

AUS_005. Other students have a stronger influence on the course #

AUS_006. Equal treatment of students by teachers

AUS_L03 Participation Activity

AUS_007. Asking questions and making comments in the course

AUS_008. Expressing opinions in the course

AUS_009. Taking responsibility by being an active participant

AUS_010. Enjoyment in taking initiative and collaborating in the course

AUS_011. Possibility to express thoughts and views without being ridiculed

AUS_012. Ease of participation in discussions

AUS_013. Difficulties participating in discussions #

AUS_014. Willingness to participate even when having other things to do

AUS_015. Courage to challenge matters presented in the course

AUS_L04 Interest and Motivation

AUS_016. The course was not inspiring #

AUS_017. High motivation to study in the course

AUS_018. The course was not inspiring because of unclear utility value #

AUS_019. The contents of the course were interesting

AUS_020. Desire to succeed in the course

AUS_021. Desire to learn in order to understand

AUS_022. Maintaining persistence in the face of the high effort demanded

AUS_L05 Self-efficacy

AUS_023. Belief in one's ability to succeed in the course

AUS_024. Belief in succeeding even in the most challenging tasks

AUS_025. Belief in successfully completing the course

AUS_026. Belief in attaining personal goals set for the course

AUS_027. Confidence in oneself as a learner in spite of challenges

AUS_L06 Competence Beliefs

AUS_028. Understanding of the course contents

AUS_029. Sufficient basis for participation in discussions in the course

AUS_030. Understanding of the constructs presented in the course

AUS_031. Experiencing course contents as too challenging #

AUS_032. Lacking basic knowledge for understanding the course contents #

AUS_033. Experience of a need for revision of basic concepts prior to the course #

AUS_034. Course demands have not been excessive

AUS_L07 Teacher Support

AUS_035. Belittling of students by teachers #

AUS_036. Teachers' friendly attitude towards students

AUS_037. Experience of being oppressed as a student #

AUS_038. Teachers' contemptuous attitude towards students #

AUS_039. Not enough room for discussion given by teachers #

AUS_L08 Peer Support

AUS_040. Experiencing other students as resources for learning

AUS_041. Providing support for other students in challenging study tasks

AUS_042. Asking for help from other students when needed

AUS_L09 Trust

AUS_043. Experience of being welcome in the course

AUS_044. Approachability of the teachers

AUS_045. Supportive course climate

AUS_046. Experience of being able to trust teachers

AUS_047. Encouraging students to participate in discussions

AUS_048. Experience of teachers' interest in students' viewpoints

AUS_049. Possibility to be oneself in the course

AUS_L10 Opportunities to Influence

AUS_050. Student viewpoints and opinions were taken into account

AUS_051. Student viewpoints were listened to

AUS_052. Experience of having to perform according to external instructions #

AUS_053. Possibility to choose contents that one finds interesting

AUS_054. No possibility to influence the course content #

Reversed-coded item