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PRACTICE ARTICLE

Using Technology-Enhanced Differentiated Instruction to Support Learning in Higher Education

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Abstract

The expansion of access to higher education, as well as the global circulation of students, herald greater diversity on campus and the need for more inclusive teaching practices. Responding to Stentiford and Koutsouris's (2021) call for expanded conversations in inclusive pedagogies in higher education, this article explores the synergistic potential of technology with differentiated instruction—a learner-centered educational approach. Technology was adopted to collect information on students' backgrounds and learning, enhance the learning environment, scaffold content outside the classroom, as well as diversify teaching processes and modalities, thus enhancing differentiated instruction practices. Students' appreciation for these practices point to the potential of technology-enhanced differentiated instruction in attending to the diverse needs of learners and achieving greater inclusion of all learners in higher education classrooms. Simultaneously, students' appreciation underscores how clear principles and reflective philosophies drive teaching and learning practices.

Keywords: differentiated instruction, inclusion, diversity, technology, pedagogy

Introduction

Higher education institutions worldwide are seeing unprecedented diversity in their campuses with the expansion of access to higher education, as well as the global circulation of students. Ethnicities, (dis)abilities, nationalities, and socio-economic statuses are but a few examples of the differences based on various facets of students' identities which contribute to diversity in higher education (Stentiford & Koutsouris, 2021). Greater diversity has prompted an urgent attention to the need for more inclusive and nuanced teaching practices—no longer does a one-size-fit-all approach work. However, Stentiford and Koutsouris (2021) have argued that widespread interest in— and

conversations about—inclusive pedagogies in higher education are recent phenomena, and it is imperative to expand the discourse on how inclusive pedagogies can be interpreted and implemented. This article aims to contribute to such discourse by discussing how technology-enhanced differentiated instruction can support diverse student populations in higher education.

Differentiated instruction (DI) is a learner-centered educational approach premised on an appreciation for learner diversity, aiming to maximize the academic potential of learners through adaptive teaching (Tomlinson, 2014). It draws upon constructivist theories of learning that assumes that learners have pre-existing knowledge and experiences that should be taken into consideration in crafting learning experiences (Tomlinson et al., 2003). Although commonly used in K-12 settings to enhance inclusion, student engagement, and achievement, the higher education community has been slower in adopting DI despite its benefits (Melese, 2019; Santangelo & Tomlinson, 2009; Turner et al., 2017). By drawing upon examples from a pedagogical exploration and research study on students' experiences with technology-enhanced DI, this article offers ideas on how technology-enhanced DI can be used as a curricular and pedagogical approach to enhance inclusion and engagement in higher education. Additionally, it hopes to encourage readers to contemplate how our philosophical assumptions on education can shape the teaching and learning principles and practices we implement.

Differentiated Instruction and Its Benefits

Differentiated instruction (DI) is a systematic and intentional way to plan curriculum and teach diverse learners. DI draws on philosophical underpinnings that include an appreciation of student diversity and the growth mindset, with educators accepting responsibilities for removing barriers to students' learning to maximize their learning potential (Tomlinson, 2014). Educators are encouraged to adapt various classroom elements, such as the learning content (or concepts, facts, and skills to be attained), process (by which students understand the content), product (that showcase their learning), and environment (in which students learn) (Tomlinson, 2014). Five principles guide the adaptation of these classroom elements: creating a supportive learning environment where students feel safe, implementing a quality curriculum that is authentic and relevant, using assessment data to inform teaching and learning, adapting instruction to students' variances, and leading and managing the classroom through the use of routines and clear instructions (Tomlinson, 2014). DI has been associated with increased academic outcomes both within K-12 (Deunk et al., 2018) and higher education (Chamberlin & Powers, 2010; Chen & Chen, 2018; Dosch & Zidon, 2014), in addition to enhanced student collaboration, interaction, and engagement (Joseph et al., 2013).

Despite these benefits, the uptake to DI has been slow in higher education. Barriers to adoption in higher education have been attributed to a lack of teacher training in DI (Melese, 2019; Santangelo & Tomlinson, 2009; Turner et al., 2017), insufficient

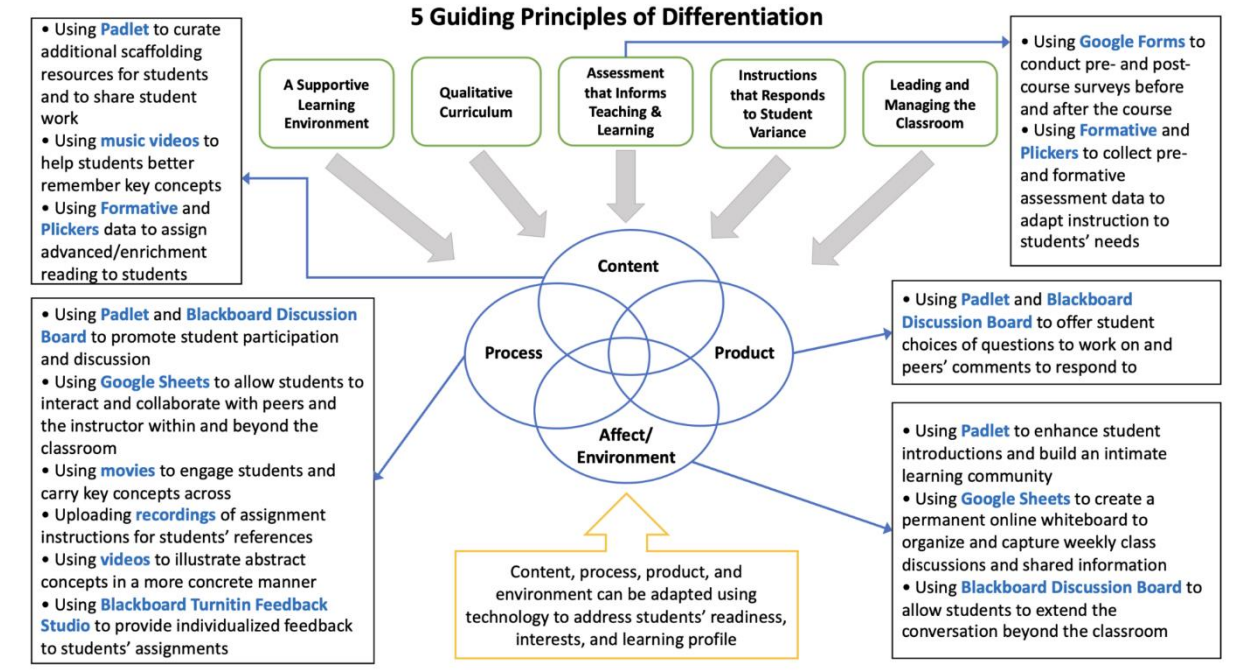
planning time (Joseph et al., 2013; Melese, 2019; Turner et al., 2017), large class sizes (Melese, 2019; Turner et al., 2017), lower familiarity with students due to fewer contact hours (Chamberlin & Powers, 2010), and faculty paying greater attention to professional obligations other than teaching (Turner et al., 2017).

Differentiated Instruction X Educational Technology

Technology has been touted as holding promise in overcoming some DI implementation barriers. College faculty who have undergone a professional development program concerning DI concluded that "when technology is used as a tool for DI, a better learning environment is created for all students" (McCarty et al., 2016, p. 41). Technology offers different platforms for learners to discuss and share ideas (Joseph et al., 2013), supports multimodal access to content and learning (McCarty et al., 2016), and provides assessment options catering to students' needs (Boelens et al., 2018). These uses of technology reflect considerations for students' prior knowledge and experiences and, thus, an alignment with constructivist learning theory. Further, when computerized systems are used to collect formative assessment information to support DI, an improvement in students' academic outcomes has been associated with a small to medium effect size (Deunk et al., 2018).

Given these promising outcomes, I sought to explore the various ways by which technological tools can support DI in higher education. Figure 1 is a summary of how DI principles (in green boxes) are used to guide how technology is used to differentiate the four classroom elements of content, process, product, and environment (in blue circles). The black boxes linked to the classroom elements and principles offer ideas for how various technological mediums—such as Padlet, Google Suite, Learning Management System (Blackboard)—can be leveraged; these practices will be unpacked in the next section.

Figure 1: Technology-Enhanced Differentiated Instruction



Brief Overview of the Teaching Context Methodology

Before unpacking Figure 1, I will offer brief contextual information driving these curricular and pedagogical innovations. The teaching took place at the National Institute of Education (NIE), an education college that is part of a Tier-One research university, Nanyang Technological University, in Singapore, which has one of the highest GDP per capita in Asia. NIE offers a range of undergraduate and postgraduate courses, attracting both part- and full-time students from various institutional contexts and countries. As a faculty member, I have seen increasing diversity amongst postgraduate students in my Masters' level course. This diversity—be it students' professional context (e.g., public vs. private schools, healthcare, military), age, student status (e.g. full- vs. part-time), and/or familiarity with Singapore's education system—poses increasing challenges in pitching lessons to appropriately address students' needs. For instance, a preschool educator may engage with certain educational ideas differently from a military educator given their professional contexts. Recent graduates are more comfortable with academic writing than those returning after a longer hiatus. Furthermore, amidst Nanyang Technological University's internationalization policy and Singapore's strategic development of higher education institutions, the number of international students has risen sharply. Some international students appear uncomfortable with classroom discussions in English and assessment expectations, exhibiting reticence and hesitance. Additionally, international students are unfamiliar with Singapore's educational system and its commonly utilized terminologies. I have observed that growing diversity beyond national lines creates

divisions, limits interactions and collaborations among students and professors, and reduces a sense of belonging and inclusion in class. International and/or full-time students tend to cluster together in class and during groupwork. Thus, by leveraging technological mediums to innovate curricular and teaching practices undergirded by DI principles in my classroom, I hoped to help my students overcome the affective, social, and learning challenges they face.

Technology-Enhanced DI Practices

In the subsequent sections, I will share information about the various technology-enhanced DI practices captured in Figure 1, as well as students' qualitative responses to these practices. These responses were extracted from a larger mixed-method research study involving 32 students who voluntarily agreed to participate and were enrolled in one of two rounds of a 13-week graduate-level module for in-service teachers. Research assistants collected data on students' experiences with the technology-enhanced practices via observations, questionnaires, and interviews. Per institutional ethics policy, as an instructor, I was only privy to the data and participants' names after course and assessment completion. Given that this is a practice- (not research-) based article aimed at sharing curricular and pedagogical ideas, students' responses are included to illuminate some perspectives, and are not meant to represent rigorous research findings.

Using Technology to Build Classroom Community

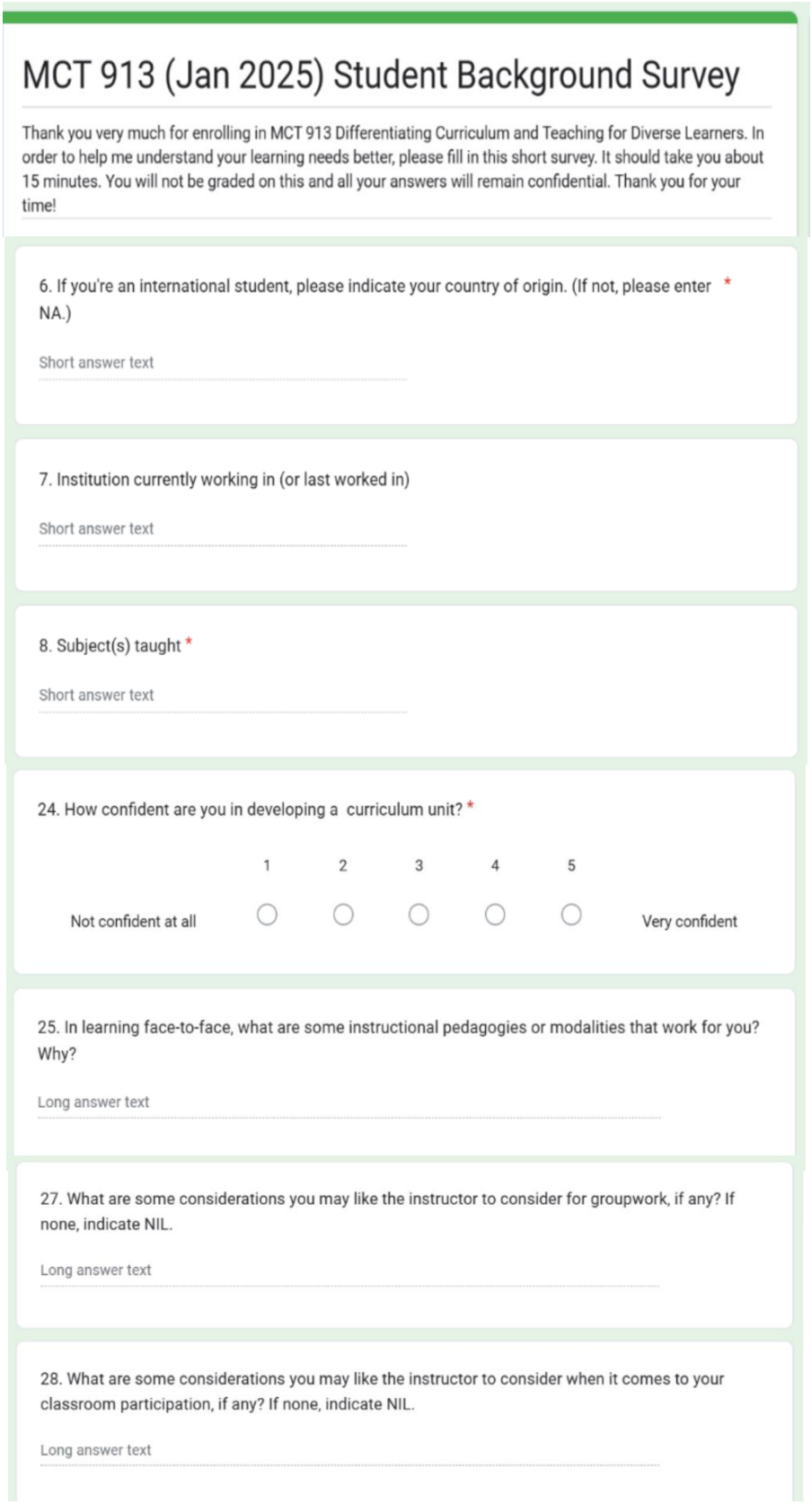
A positive and supportive classroom environment is essential for learning to take place; thus, students need to feel comfortable with each other (Stentiford & Koutsouris, 2021; Tomlinson, 2014). To help students get to know each other better, before the first class, they were invited to give a brief introduction of themselves on the class Padlet. Doing so helped break the ice amongst them, consequently lubricating interactions in class and facilitating organisation for group assignments. By asking students to share something not often known about themselves, they were given a chance to see a more personal side of their peers, allowing for connections beyond the professional. Students shared that the Padlet was a "nice way to know everyone and hear from them [as] it made getting to know them less intimidating, especially for individuals who are more introverted and/or less verbally expressive." Learning more about their peers helped them "understand the background of [their] classmates so that [they were] able to put [themselves] in their [classmates'] shoes during class discussion." Moreover, students felt that the Padlet made it easier for them to approach a "stranger" on assignment collaboration as they felt "surrounded by people [they] know."

Figure 2: Student Introduction Padlet

Using Technology to Support Assessment

Formative assessment is essential to differentiated instruction as the collection of information related to students' learning, interests, and preferences can feed forward into adaptive curricular and instructional design (Moon & Tomlinson, 2013). Assessment can take place at various times. Before the first lesson, I invited students to complete a "Student Background Survey" via GoogleForm to collect information pertaining to their prior knowledge, interests, learning mode preferences, as well as to open up a space for students to articulate any concerns they may have (see Figure 3). Collected data were used to organize subsequent instruction and sensitize the instructor to students' needs, like their preferred mode of learning or preference in classroom participation. Additionally, the information was used to organize students in either heterogeneous or homogeneous groups—for instance, students who lived in the same regions in Singapore were invited to sit together for the first two lessons so that carpooling could take place to ease their travels to school or back home.

Figure 3: Excerpt of Student Background Survey



MCT 913 (Jan 2025) Student Background Survey

Thank you very much for enrolling in MCT 913 Differentiating Curriculum and Teaching for Diverse Learners. In order to help me understand your learning needs better, please fill in this short survey. It should take you about 15 minutes. You will not be graded on this and all your answers will remain confidential. Thank you for your time!

6. If you're an international student, please indicate your country of origin. (If not, please enter NA.) *

Short answer text

7. Institution currently working in (or last worked in)

Short answer text

8. Subject(s) taught *

Short answer text

24. How confident are you in developing a curriculum unit? *

	1	2	3	4	5	
Not confident at all	○	○	○	○	○	Very confident

25. In learning face-to-face, what are some instructional pedagogies or modalities that work for you? Why?

Long answer text

27. What are some considerations you may like the instructor to consider for groupwork, if any? If none, indicate NIL.

Long answer text

28. What are some considerations you may like the instructor to consider when it comes to your classroom participation, if any? If none, indicate NIL.

Long answer text

During the lessons, formative assessment was implemented using the online software Formative. Formative assessment data were collected to check on students' understanding of content taught, as well as assignment instructions. Pertaining to the latter, I administered a quiz via Formative to elicit students' understanding of the assignment demands for more complex performance tasks that involved extended instructions (Figure 4). Consequently, feedback was given to students to correct any erroneous understanding they had prior to their embarkation on the assignment (Figure 5). Students appreciated regular formative assessment via Formative as it "[enabled them] to assess [their] own understanding after the lesson and surface [their] own misconception." Further, they recognized that the data also "guides teachers in planning instruction and lessons."

Figure 4: Using Formative to Assess Students' Understanding of Assignment

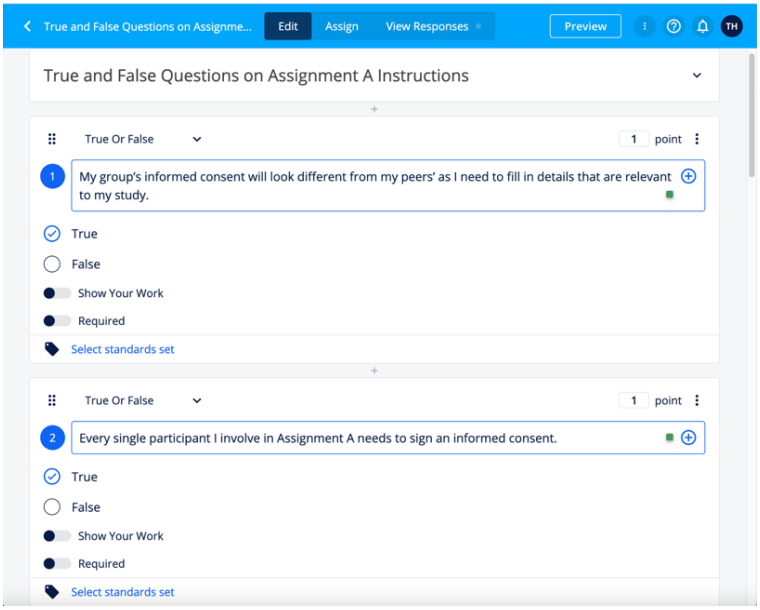
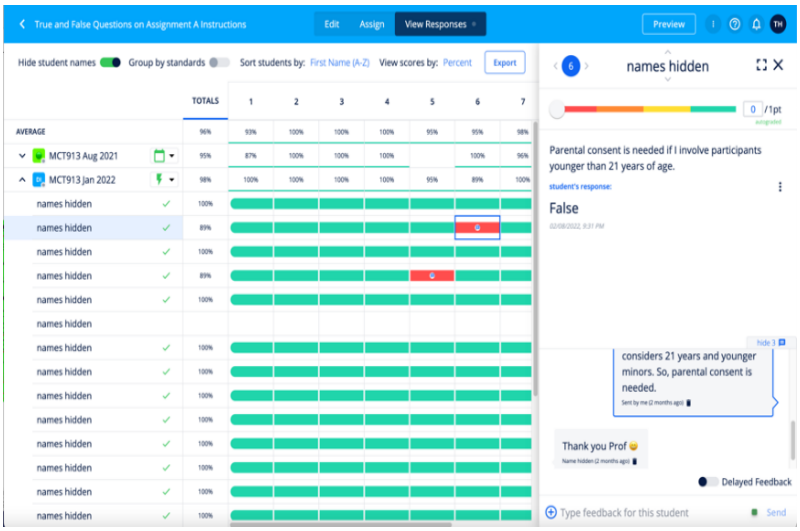
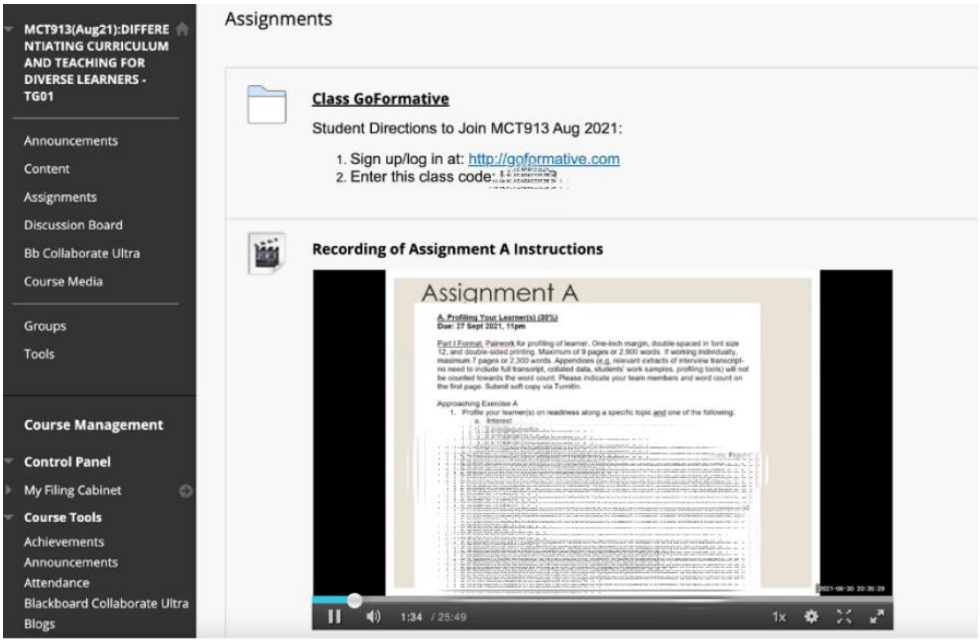


Figure 5: Using Formative to Give Feedback to Students



Complementing formative assessment check-in on students' understanding of assignment instruction was the recording and uploading of assignment instructions in the Learning Management System (Figure 6). Recordings for instructions for more complex tasks were made available to students so that they could refer to the instructions whenever necessary, reducing the frequency in which they had to clarify their questions with the instructor. Students commented that having the video recording "helped to set the expectations, clarify any doubts that [they] may have about the assignments."

Figure 6: Uploading Recordings of Assignment Instructions Online



Differentiating Content Using Technology

As students had different levels of familiarity with the Singapore education system, as well as varying competencies and comfort with academic writing, I created and shared two Padlets around these two topics at the beginning of the module to serve as resources to extend learning beyond the classroom.

Given the different nationalities and institutional backgrounds of students, the Singapore education system Padlet offered background information arising from differing institutional and sociocultural contexts. Students felt that the Padlet "gives a good overview of Singapore edu [sic] system from the outside especially for foreigner students" and observed that international peers appeared better able to keep up with classroom discussions as the Padlet helped to bridge the "gap between international students and local students."

The second Padlet curated textual, visual, and online writing resources. Students shared that writing could be a big challenge in the first semester and found the Padlet useful in helping them work through technicalities, such as "APA citations," and insights learned were "helpful for other modules."

Figure 7: Padlet on Singapore Education System

Screenshot of the Singapore Education Resource Padlet showing information organised by categories such as Singapore Education System, and Curriculum and Teaching in Singapore.

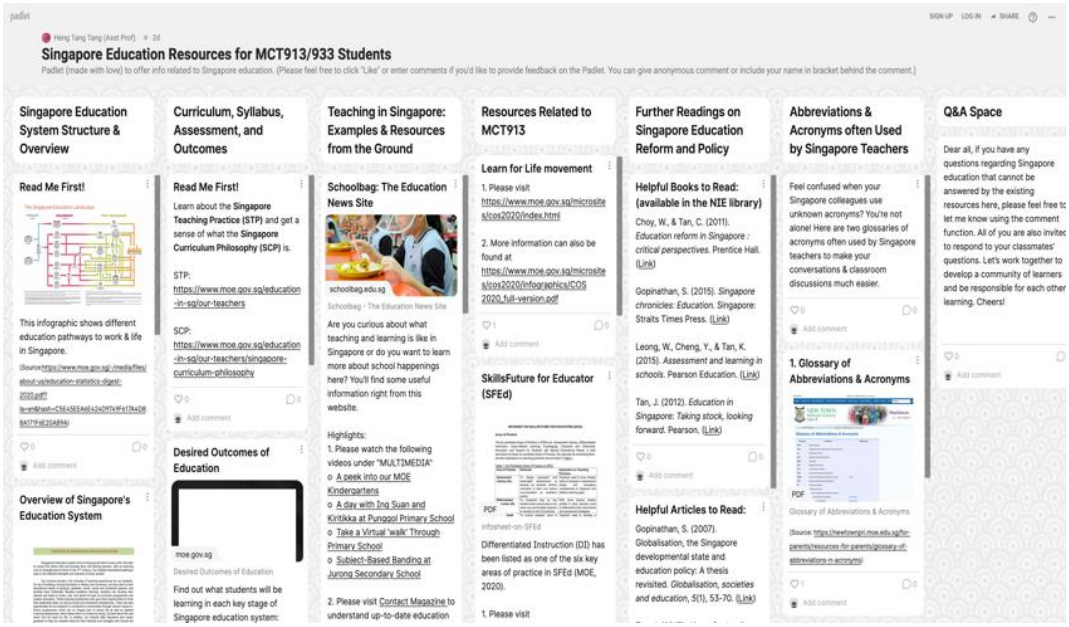
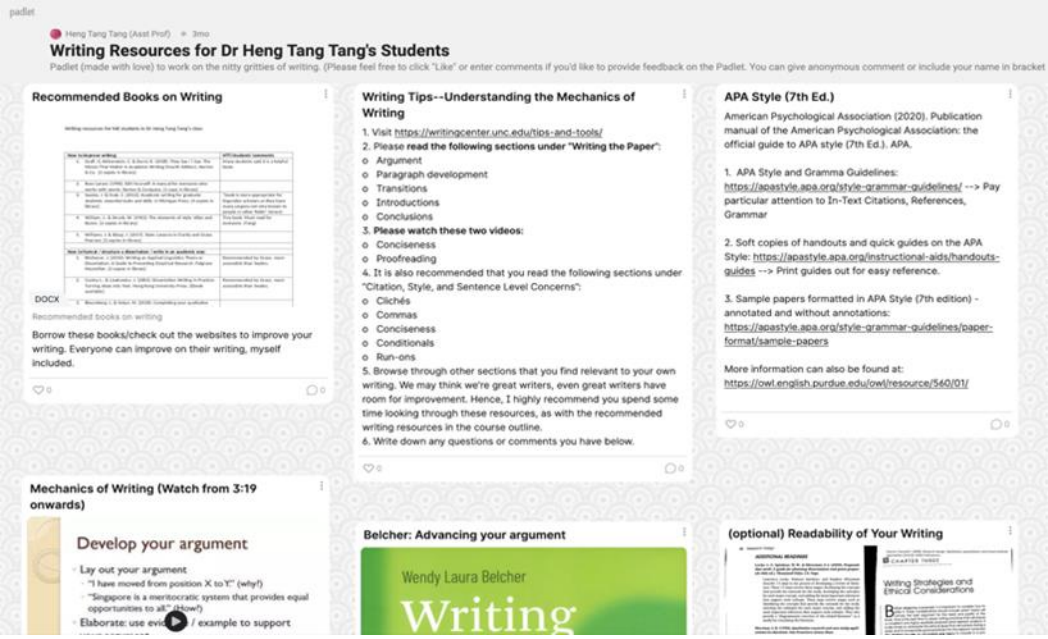


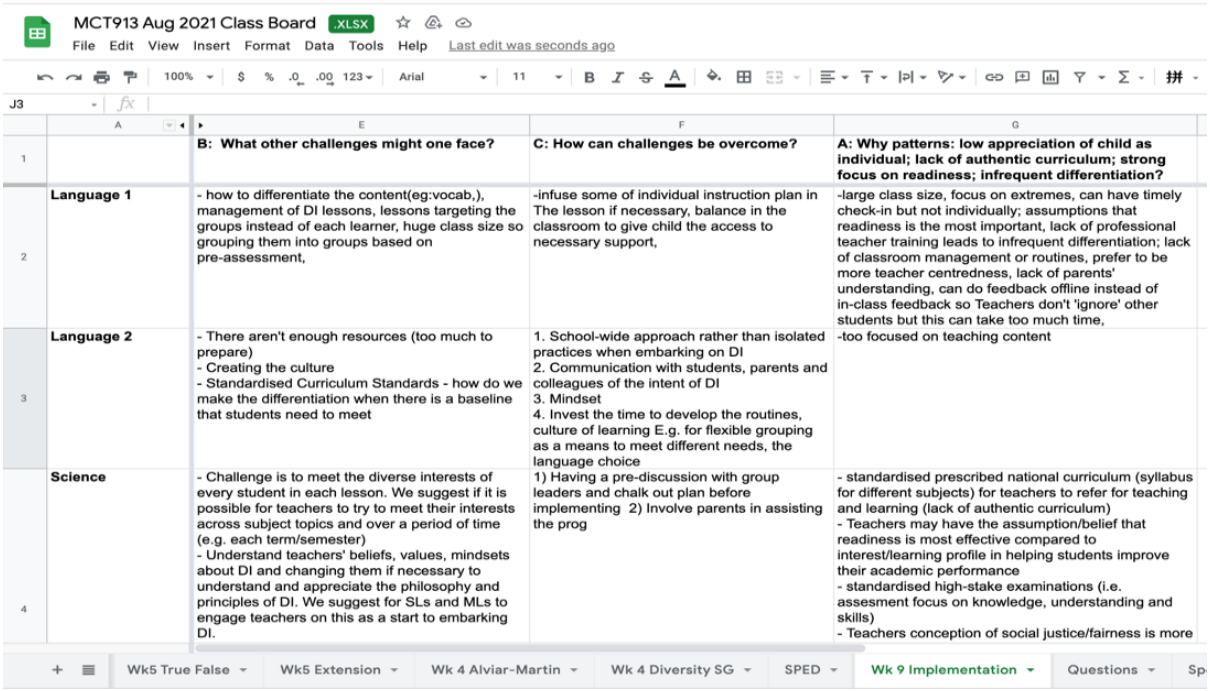
Figure 8: Padlet on Academic Writing



Differentiating Process Using Technology

The learning process was also enhanced with the help of technology tools. Using GoogleSheet, I created a class E-Board (Figure 9) to capture weekly discussions across groups so that students could be cognizant of their peers' discussions. Moreover, this E-Board served as a visual archive of weekly discussions that we returned to, and to which students could reference should they have trouble following classroom discussions. Students appreciated this evergreen E-Board as "it [allowed them] to capture [their] points of discussion, revisit the discussion points even after lessons have ended. Furthermore, [they got] to view others' points too enabling multiple perspectives." Thus, the E-Board served as a vehicle through which students felt more included in class.

Figure 9: Group Discussions Captured in Class E-Board



MCT913 Aug 2021 Class Board .XLSX

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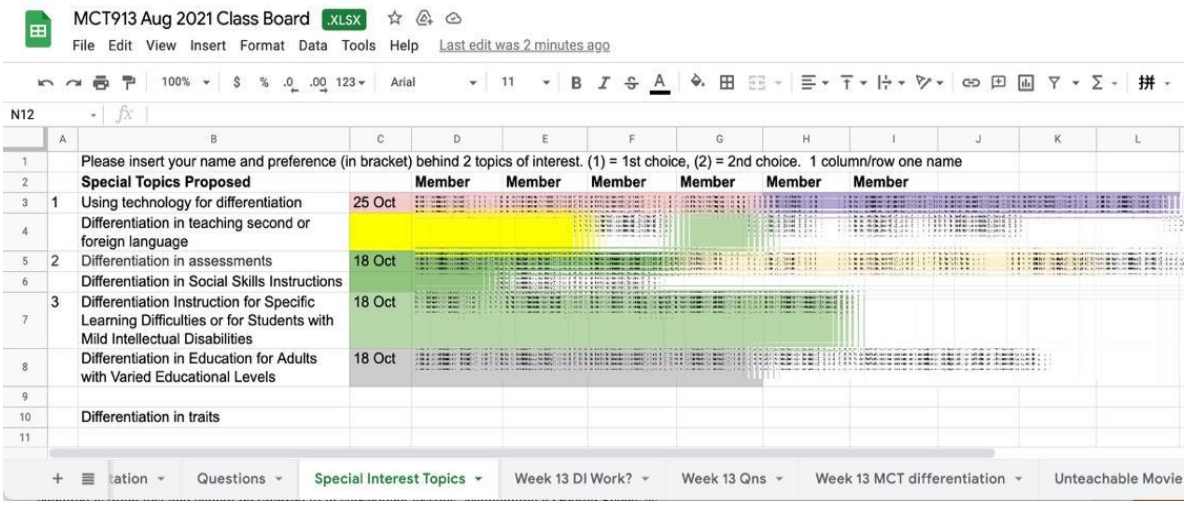
		B: What other challenges might one face?	C: How can challenges be overcome?	A: Why patterns: low appreciation of child as individual; lack of authentic curriculum; strong focus on readiness; infrequent differentiation?
2	Language 1	- how to differentiate the content(eg:vocab,), management of DI lessons, lessons targeting the groups instead of each learner, huge class size so grouping them into groups based on pre-assessment,	-infuse some of individual instruction plan in The lesson if necessary, balance in the classroom to give child the access to necessary support,	-large class size, focus on extremes, can have timely check-in but not individually; assumptions that readiness is the most important, lack of professional teacher training leads to infrequent differentiation; lack of classroom management or routines, prefer to be more teacher centredness, lack of parents' understanding, can do feedback offline instead of in-class feedback so Teachers don't 'ignore' other students but this can take too much time,
3	Language 2	- There aren't enough resources (too much to prepare) - Creating the culture - Standardised Curriculum Standards - how do we make the differentiation when there is a baseline that students need to meet	1. School-wide approach rather than isolated practices when embarking on DI 2. Communication with students, parents and colleagues of the intent of DI 3. Mindset 4. Invest the time to develop the routines, culture of learning E.g. for flexible grouping as a means to meet different needs, the language choice	-too focused on teaching content
4	Science	- Challenge is to meet the diverse interests of every student in each lesson. We suggest if it is possible for teachers to try to meet their interests across subject topics and over a period of time (e.g. each term/semester) - Understand teachers' beliefs, values, mindsets about DI and changing them if necessary to understand and appreciate the philosophy and principles of DI. We suggest for SLs and MLs to engage teachers on this as a start to embarking DI.	1) Having a pre-discussion with group leaders and chalk out plan before implementing 2) Involve parents in assisting the prog	- standardised prescribed national curriculum (syllabus for different subjects) for teachers to refer for teaching and learning (lack of authentic curriculum) - Teachers may have the assumption/belief that readiness is most effective compared to interest/learning profile in helping students improve their academic performance - standardised high-stake examinations (i.e. assesment focus on knowledge, understanding and skills) - Teachers conception of social justice/fairness is more

Wk5 True False | Wk5 Extension | Wk 4 Alviar-Martin | Wk 4 Diversity SG | SPED | Wk 9 Implementation | Questions | Sp

Additionally, this E-Board served as a platform to organize students into presentation groups. Often, the assumption in higher education is that adult learners are able to self-organize. However, I observed that students tended to organize themselves into project groups according to who they knew, as opposed to what they are interested in. Consequently, I tasked students to propose topics they would like to pursue for their projects on the E-Board so that they could self-organize into groups aligned to their interests (Figure 10). Doing so also meant that no student would feel left out as they self-elect into various proposed topics. Furthermore, students are invited into the curriculum planning so that their learning can be made relevant to their needs. Students felt that the E-Board "provided an open space for [students]… altering [their] topics from one to another" and was "especially effective to link people up from similar fields when [they didn't] know each other yet."

Figure 10: Using the E-Board to Coordinate Group Projects



Conclusion

The above ideas illustrate how DI can be enhanced with the use of technology to overcome barriers to its adoption in higher education. More importantly, these ideas showcase how technology-enhanced DI practices can be used to heighten students' emotional and social inclusion in the higher education classroom, increase engagement in class, as well as attend to various learning needs (e.g., their varying interests or readiness in a topic) and preferences (e.g., groupwork preferences or learning extensions beyond the classroom). Students reported an appreciation for the learning and socialization scaffolding, thus pointing to the applicability and helpfulness of technology-enhanced DI in higher education. This exploration of how an inclusive pedagogical approach like DI can be augmented with technology corroborates and expands the conversation on the synergistic potential of both (McCarty et al., 2016; Boelens et al., 2018) and responds to Stentiford and Koutsouris's (2021) call for greater discourse on inclusive pedagogies in higher education.

While some of the tools or strategies shared in this article may not be accessible or applicable in different contexts, I hope that readers can gain appreciation for the principles and philosophies undergirding these practices. In particular, Tomlinson's (2014) principles (below) can guide higher education educators' curricular and pedagogical approaches to address learner diversity in their contexts, beyond the examples illustrated above. Where learner diversity is not a cause for concern, some of these principles can help us reflect on our own teaching as we work out what is suitable for our own contexts:

- Creating a supportive and inclusive learning environment,
- Offering a quality curriculum that is authentic and relevant,
- Using assessment data to inform teaching and learning,
- Adapting instruction to students' variances,
- Using routines and offering clear instructions

Further, in contexts where technology is not easily available, embracing the philosophical intent can similarly arrive at the same goals. For instance, instead of using Padlet to build an online classroom community, teachers can facilitate in-class introductions to build community. Instead of creating online content extensions to support learners, teachers can provide hard copies of content on academic writing or sociocultural-contextual information related to lesson content (e.g., a list of acronyms) to address learners' needs. Instead of using software or online surveys to collect student (assessment) data, offering print outs or having students respond with hand gestures can circumvent technological constraints to collect data on learners' needs. These practices are driven by the philosophical beliefs that all learners should be valued and teachers are responsible for removing learning barriers.

Fundamentally, what I hope to achieve through this article is not to preach rigid applications of DI philosophies, principles, or practices (technologically-enhanced or not). Rather, by offering practical ideas of how DI practices can be synergized with technology, I underscore the necessity for educators to reflect on their personal teaching and learning philosophies and contemplate how their philosophies drive the principles and practices they use. Developing an appreciation for and belief in the philosophies undergirding DI is one—but not the only—inclusive pedagogical approach. I hope that the ideas in this article can catalyse conversations on the philosophical stance educators may need to nurture in their contexts, so that different learners can equitably access learning in higher education.

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Ethics Addendum

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AI Statement

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