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Using Laurillard’s learning types as a lens for course design in a chemical engineering undergraduate course

Oluwaseun Oyekola

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Chapter in brief

The COVID-19 pandemic created a series of conditions that required the redesign of a Chemical Engineering course at a university of technology. Faced with constrained access to digital infrastructure, limited digital literacies and historically poor preparedness for engineering as a field of study, I sought to create a learning design that mitigated both the long-standing challenges of the context and the more immediate constraints posed by emergency remote teaching. This chapter discusses the application of Diana Laurillard's six learning types in the context of emergency remote learning in a second-year chemical engineering course. The learning types, Acquisition, Inquiry, Practice, Discussion, Collaboration, and Production, are connected to analogue and digital learning activities. Laurillard's framework is used to design a varied and responsive learning environment that includes digital tools such as YouTube, Zoom, WhatsApp, and others. The chapter reflects on the challenges faced during remote teaching, emphasising the importance of connection and community. Strategies like the "Buddy System" and building teacher presence through various tools are discussed. The study concludes with insights into the transformative learning experience, advocating for a continued shift towards innovative and flexible teaching approaches in the post-pandemic era.

Introduction

The COVID-19 pandemic posed challenges for universities of technology (UoT). In the South African context, UoTs tend to offer programmes and courses that require specialist learning environments and tools while simultaneously attracting and admitting students from historically disadvantaged communities with lower income levels and poor preparedness for post-secondary education. During the early months of the COVID-19 pandemic, government-imposed lockdowns restricted free movement, halted access to public spaces and closed all parts of the economy except essential activities. Students were initially required to evacuate university residences and were only allowed to return to residences and classrooms later in 2020, in reduced numbers. Faced with the constraint of lockdowns and the later extended period of restricted indoor gathering, most post-secondary institutions pivoted to emergency online or remote learning and teaching (RTL). In South Africa, as in other unequal and resource-poor environments, these attempts to continue teaching online had to take into consideration access to devices, access to and cost of internet access and students limited digital literacy for learning purposes.

This chapter describes how within the undergraduate Chemical Engineering programme at Cape Peninsula University of Technology (CPUT) – a university of technology, we adopted a multimodal approach to RTL. The chapter unpacks the learning approach and learning design that made use of Laurillard's six learning types (1999).

Teaching and learning at CPUT: Contextualising the case

CPUT is the only UoT in the Western Cape province of South Africa. Many of the students admitted to CPUT are from historically disadvantaged communities and backgrounds where they are not exposed to or have limited access to information and communication technology (ICT) facilities and internet connectivity. Navigating the constraints of the pandemic while seeking to provide a more active, student-centred course design was a challenging context.

Teaching Chemical Engineering at CPUT prior to the pandemic

This study focuses on a compulsory whole year chemical engineering course, Chemical Engineering Thermodynamics, usually attended by about 250 second year students. Chemistry and Mathematics are prerequisites for this course. This course is foundational to other chemical engineering subjects as students are introduced to concepts that translate fundamental knowledge (learnt in chemistry, physics and mathematics) to applications. The course provides foundational knowledge to solve chemical engineering problems in chemical processes and plant operations.

Prior to the pandemic, the course was divided into a series of independent units or modules of study taught, primarily in person, over 13 to 15 weeks. Students attended lectures, tutorials and laboratory or workshop sessions in person. Notes, lecture slides and other audio-visual aids as well as quizzes and other formative assessments are delivered using Blackboard, the university's learning management system (LMS). Assessment consisted of both continuous and summative components. During term, students completed tutorials for a small portion of their grade, and class tests. This continuous assessment component was combined with their final examination (summative assessments) and undertaken in an examination block at the end of the course. The course assessment process was internally and externally moderated. Additionally, students could access lecturers in person, during office or consultation hours or by appointment.

As is the case in other similar contexts (see for example, Mutch, 2003; Simpson, 2015), my students' engagement is strongly shaped by assessment practices and, in particular, weight-bearing summative assessment. Most of my students are, understandably if problematically, primarily concerned with doing well in the assessments in order to achieve their highest possible grade. The practice of learning primarily to pass an assessment is labelled "surface learning" (Biggs & Tang, 2007). Surface learning is understood to be compelled by or connected to circumstantial factors in a student's life that do not necessarily link directly to the requirements of the university (Biggs & Tang, 2007). In contrast to surface learning, in deep learning, students are inquisitive about the subject matter and engage

meaningfully with it (Dolmans et al., 2016). Students do not just recollect facts but understand concepts and are able to link new concepts to prior knowledge (Howie & Bagnall, 2013). Deep learning often results in student satisfaction and confidence while teachers evoke active rather than passive interaction with students (Biggs & Tang, 2007). Thus, even in the pre-COVID-19 context, the practice of surface learning or assessment-driven learning was dominant and needed attention during the learning design process.

As mentioned, CPUT admits students from many disadvantaged groups, whose backgrounds and educational experiences do not prepare them well for studying at higher levels. Navigating the transition to learning not only in the UoT context, but also in a blended context, can be daunting for some students whose learning experiences have been dominated by face-to-face classrooms and teacher-dominated pedagogies in secondary schooling. Careful attention will need to be paid to support systems, including tutorials, lecturer consultation, peer learning and social media platforms. Many first years at CPUT have limited knowledge and experience of ICT and educational technologies. If they live off campus, they are likely to have limited access to devices and the internet. In addition to enabling access where possible, it is necessary to actively introduce students to the use of computer hardware, software, emails, internet and social network sites.

Additionally, the language of learning and teaching in the institution poses a barrier for some students. Many students' home languages are local African languages while some international students are most confident using Portuguese- or French as their language of learning and teaching. The institution also teaches communication skills to strengthen students' expression of themselves in English both orally and in writing.

The COVID-19 disruption

CPUT followed the South African government directive during the lockdown, cancelling all face-to-face operations and closing official university residences. When, after the initial hard lockdown, the Department for Higher Education and Training (DHET) gave directives for the continuation of teaching through RTL, CPUT had to devise a teaching and learning response that considered the individual situations and collective context of the students. The initial approach was to have most (~90%) teaching and learning activities online while students would only come to campus to carry out practical activities and final summative assessments if required.

As is the case with many UoTs, CPUT students often face economic and associated material constraints, thus, the CPUT response needed to consider the limited access to ICT facilities and internet connectivity our students experienced in their homes and private spaces. The CPUT executive management made agreements with all mobile network operators, as negotiated by Universities South Africa and DHET, to provide students with a free allocation of 10GB of mobile data if they were registered with any of the country's four main mobile network providers (Vermeulen, 2020). Additionally, the major mobile operators announced zero-rating for a selection of educational sites, including institutions' LMS, providing free access to course materials for students (Jantjies, 2020).

At the onset of the pandemic, while affordances were considered in the choice of tools and technologies, choices were primarily dictated by the cost of data and availability of ICT facilities and infrastructure, such as network capacity or LMS access. At CPUT, lecturers were expected to have their lecture content on CPUT's LMS, which was zero-rated, to entirely replace face-to-face teaching. Before the pandemic, the LMS had primarily been used for administrative purposes and as a repository for teaching and learning materials.

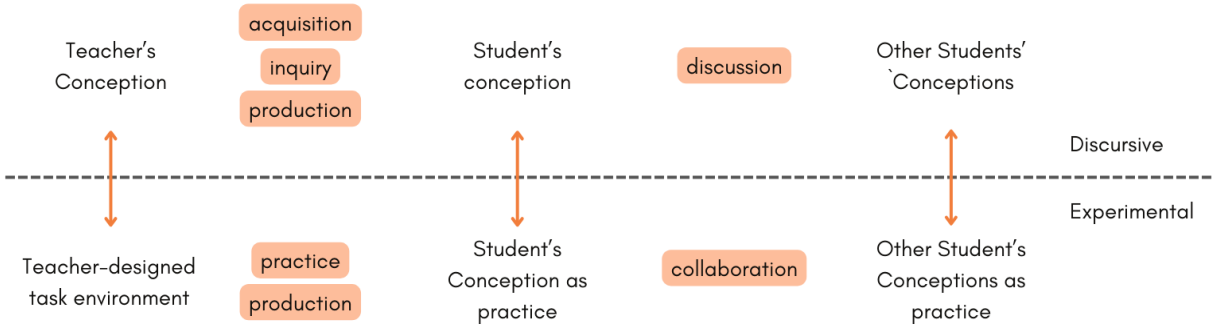
While the LMS offers multiple affordances for teaching and learning at CPUT, most educators migrated to the online space by simply "digitising" their conventional face-to-face teaching materials. In some cases, synchronous and asynchronous multimodal delivery of content was implemented and staff attempted to enable synchronous and asynchronous interaction with learning pathways. Unfortunately, given the limited resourcing and rapid nature of the shift online, little attention was paid to learning design or instructional design practices. Meyer (2014) notes: "emphasis placed on interaction without being clear about an educational goal or learning objective may have inadvertently created some of the problems of poor student engagement" (2014, p. 40). It is possible that this has been the case at CPUT.

Designing with Laurillard's six types of learning

Laurillard's conversational framework (1999) draws on key elements of the learning process – associative, cognitive, experiential, social constructivist, conceptual, constructionist and collaborative learning (Laurillard, 2012, p. 84) to offer a framework for understanding formal learning. The conversational framework brings together instructionism, social learning, constructionism and collaborative learning to offer a "representation of what it takes to learn" (Laurillard, 2009, p. 11). By offering four cycles to represent the complexity of teacher-learner interactions in formal learning environments, Laurillard extracts six learning types that emerge across educational contexts, describing this "rich mix of activities" as "fuelling the impulse to build a more effective knowledge structure, and more skilled ways of using it" (2012, p. 95). It was the six learning types: acquisition, inquiry, practice, production, discussion and collaboration which emerged from these cycles that I found most useful in designing learning activities. Figure 1 from Feist's representation (2022) displays how Laurillard locates these learning types within the conversational framework.

Figure 1

Learning types (Feist, 2022, p. 35)



In Figure 1, in the discursive band of activities, Laurillard connects the teacher's conception with the student's conception through the learning types of acquisition, inquiry and production; students connect their conceptions with the conceptions of other students through the discussion learning type. Below the line in Figure 1, in the experimental band, Laurillard connects the teacher-design task environment to the student's conception as practice through the learning types of practice and production. The student's conception as practice connects to other students' conceptions as practice through the collaboration learning type.

The learning design that emerged during the remote learning phase drew strongly on the six learning types outlined by Laurillard. Each learning type is reinforced by different learning theories and finds expression in different kinds of learning activities either in face-to-face or online contexts. Laurillard (see Table 1) connects each learning type with the kinds of analogue and digital learning activities that best enable that type of learning.

Table 1

Types of learning and the different types of analogue and digital learning activities that serve them (Laurillard, 2012, p. 96)

Learning through	Analogue learning activities	Digital learning activities
Acquisition	• Reading books or papers; • Listening to teacher presentations face-to-face, lectures; • Watching demonstrations, master classes.	• Reading multimedia, websites, digital documents and resources; • Listening to podcasts or webcasts; • Watching animations or videos.

Learning through	Analogue learning activities	Digital learning activities
Inquiry	• Using text-based study guides; • Analysing the ideas and information in a range of materials and resources; • Using conventional methods to collect and analyse data; • Comparing texts, searching and evaluating information and ideas.	• Using online advice and guidance; • Analysing the ideas and information in a range of digital resources; • Using digital tools to collect and analyse data; • Comparing digital texts, using digital tools for searching and evaluating information and ideas.
Practice	• Practising exercises; • Doing practice-based projects, labs, field trips, and face-to-face role-play activities.	• Using models, simulations, microworlds, virtual labs and field trips, and online role-play activities.
Production	• Producing articulations using statements, essays, reports, accounts, designs, performances, artefacts, animations, models, • Videos.	• Producing and storing digital documents, representations of designs, performances, artefacts, animations, models, resources, slideshows, photos, videos, blogs, e-portfolios.
Discussion	• Tutorials, seminars, email discussions, discussion groups, online discussion forums, class discussions, blog comments.	• Online tutorials, seminars, email discussions, discussion groups, discussion forums, web-conferencing tools, synchronous and asynchronous.
Collaboration	• Small group project, discussing others' outputs, building joint output.	• Small group project, using online forums, wikis, chat rooms, etc. for discussing others' outputs, building a joint digital output.

The term "learning technologies" is commonly used to refer to digital technologies or media used specifically for learning. Laurillard proposes five categories of learning technologies which support educators in making decisions about the adoption of specific learning technologies. Feist (2022, p. 40) summarises Laurillard's categories as follows and offers examples of each:

- Narrative: YouTube, PowerPoint, Canva
- Interactive: Websites, Wikipedia, E-books
- Communicative: Zoom, WhatsApp, Google Classroom, Microsoft Teams, Mentimeter, Kahoot
- Adaptive: Simulations, Branching scenarios, Minecraft
- Productive: Adobe Spark, Camtasia, Google Applications, Jamboard.

In some cases, these tools may be designed for purpose, such as an LMS or quizzing tools. In other cases, educators may make use of widespread tools such as word processing tools, presentation tools, video conferencing tools and even social media to achieve educational objectives.

Given that I was working in a primarily online context, the context pushed us towards the version of activities that are described in the digital learning activities column in Table 1 above. In the section below, I discuss how particular learning types, learning activities and categories of tools were connected to create a particular learning design that sought to respond to a particular moment in time in my context as a chemical engineering lecturer. It is worth noting that not all learning activities fit neatly into one learning type, but instead activities may be made up of a combination of multiple learning types. Therefore, there are some activities or strategies discussed across learning types.

Acquisition

Acquisition refers to listening to the teacher, watching a demonstration or video recording and reading notes, a book, journal articles or websites. Acquisition activities afford the learner access to the teacher's conceptual world. It is typically didactic (Laurillard, 2012) and students take a relatively passive role, not actively generating ideas or engaging in practice, but being exposed to the understanding of and reviewing the practices of experts (Feist, 2022). This learning type found expression in the course with YouTube videos, screencasts, presentations using PowerPoint slides and web resources. Figure 2 provides an example of the use of PowerPoint slides, combined with the whiteboard function in video conferencing software during a live, online presentation to support acquisition of information (Oyekola, 2020).

Figure 2

Screenshots of my class recordings: (a) Making a calculation (b) Presenting my slides via PowerPoint

An over-emphasis on acquisition-oriented activities tends to align with learning theories which position students as more passive learners, absorbing knowledge, rather than actively constructing their own understandings. While acquisition is a common learning type in most undergraduate engineering degrees, the task of acquiring knowledge is balanced by needing to make active use of that information. Learning in this field may include

> *repetition, positive feedback, and the freedom to develop the skill without fear of failure. There is also a socialising aspect to this approach, and an opportunity to reinforce the kind of social behaviour desired in engineers, in addition to professional skills (Cropley & Sitnikova, 2005, p. 7).*

After delivering the subject content to students, in the form of love or recorded lectures, notes and resources, students undertake formative assessments in the form of online quizzes. I needed to strike a balance between acquisition of knowledge and more active learning approaches which are key to engineering. To do so, I focused on creating opportunities for the other learning types which position students as more active learners. Further, the theoretical knowledge acquired in the course that I teach, is applied in another subject (Chemical Engineering Laboratory) where the inquiry process is foregrounded as experiments are conducted. This creates an opportunity for more active forms of learning and practice in the curriculum of the programme, if not of the individual course.

Inquiry

Inquiry, in some ways akin to a scholarly research process, invites learners to identify questions, find appropriate resources and evaluate their findings. The learner is more in control while the lecturer plays the role of guiding and coaching. The overarching pedagogical strategy for this learning type is the undertaking of research independently from information shared by the educator. The inquiry learning type can be adopted concurrently with other learning types, commonly acquisition and collaboration, and can find expression in a wide range of activities including reading, discussions and reporting, using physical and web resources to conduct project-based learning activities. Inquiry can be associated with constructivist understandings of learning. As the student engages in inquiry, their conceptualisations of the world are changed, creating their understandings of the world. During the pandemic in this course, opportunities for inquiry were severely constrained.

Discussion

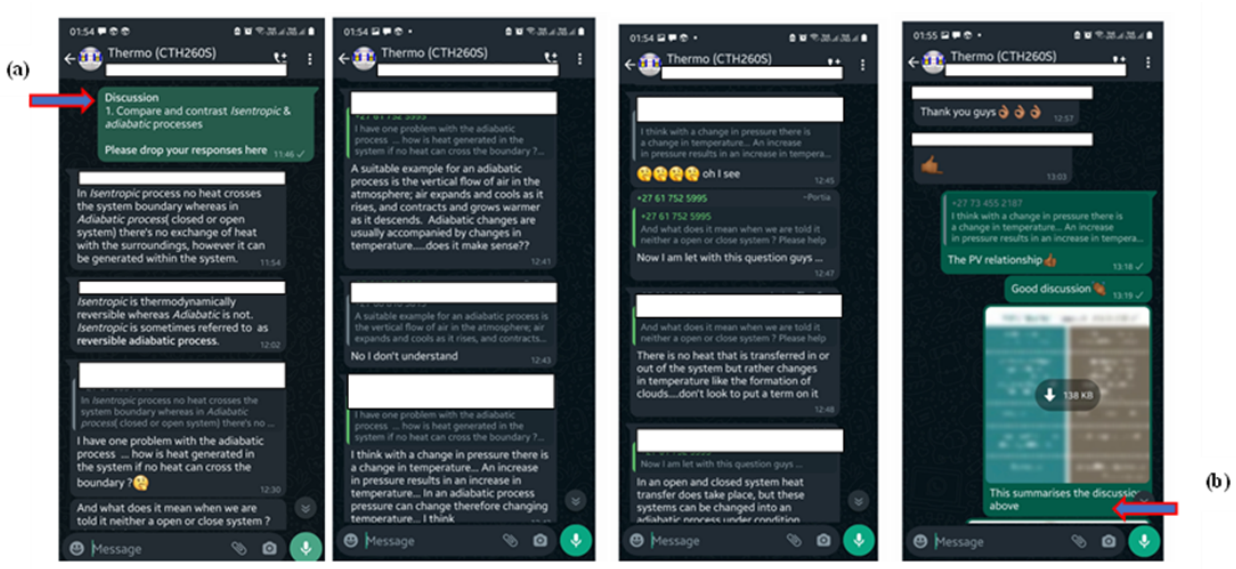
The discussion learning type requires a learner “to articulate an idea, and to negotiate, in the continual iteration of discussion, the terms of the linguistic representation of an argument or idea” (Laurillard, 2008, p. 9). While the lecturer may be involved, Laurillard emphasises the importance of discussion primarily between peers. Continuous discussion

results in progressive knowledge creation and understanding. This approach is underscored by social constructivism which promotes learning as a social process and the dependence of all cognitive functions on interactions with others.

Asynchronous online discussion forums on the LMS and WhatsApp are useful spaces to engage in discussion. As shown in Figure 3, the discussion was initiated and summarised by the lecturer. The discussion started with a simple prompt in the class WhatsApp group: Compare and contrast isentropic and adiabatic processes. Please drop your responses here. The students were expressive and engaging. As the discussion ensued, expressions from certain students changed from what does it mean? to “no I don’t understand” to “oh I see” and “thank you guys”. Typically, in the face-to-face mode of instruction, discussions are held during class and tutorial sessions; only few students participate. The anonymity or distance afforded by social media platforms, seemed to encourage more students to express themselves. Hence, this approach supported the students’ engagement as they were empowered to become independent and self-directed learners (Manyukhina & Wyse, 2018).

Figure 3

Screenshots of class discussion in the WhatsApp group after a lecture



Through the continuous exchange of meaning and varied types of interactions among participants authentic learning is ensured (Alvarez & Olivera-Smith, 2013; Suanpang, 2012). This further fosters a sense of social connection among the students (Balaji & Chakrabarti, 2010)

Practice

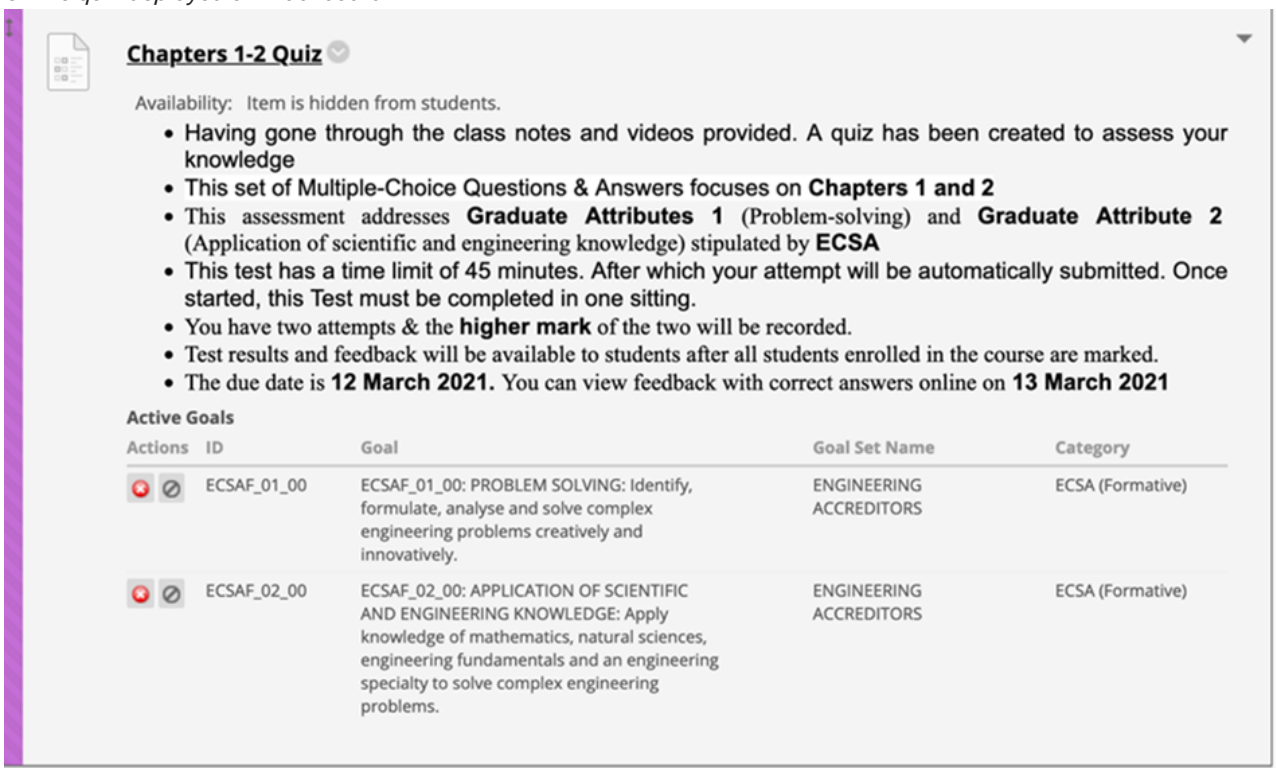
In the case of the practice learning type, the lecturer creates a learning environment where the learner produces an action, interprets it, receives feedback, reflects on the feedback and tries again. Online quizzes were generated on the LMS to achieve this (Oyekola, 2020). The learner received feedback, provided by the lecturer or through peer or automated feedback and has an opportunity for incremental improvement. Learning outcomes in alignment with the graduate attributes prescribed by the Engineering Council of South Africa (ECSA) were set out at the beginning of the semester and were assessed through some of the quizzes. Further, quizzes were set for each chapter taught in the subject (Figure 4).

Typically, knowledge acquired in each chapter is essential for the subsequent one. The regular testing of students’ acquisition of knowledge allows students to assess their own understanding by “measuring the proximity of their behaviour (answering questions, writing reports and essays, performing laboratory experiments, etc.) to the expected outcome” (Emami, 2009, p. 3). This is critical because of the sequencing and scaffolding of the chapters. Ensuring that students attempt each quiz immediately after a chapter is completed affords the opportunity to identify gaps in

students' knowledge. Hence, remediation can be provided more appropriately such as re-emphasising concepts students found difficult to grasp in class and encouraging private sessions with tutors and teaching assistants.

Figure 4

Online quiz deployed on Blackboard



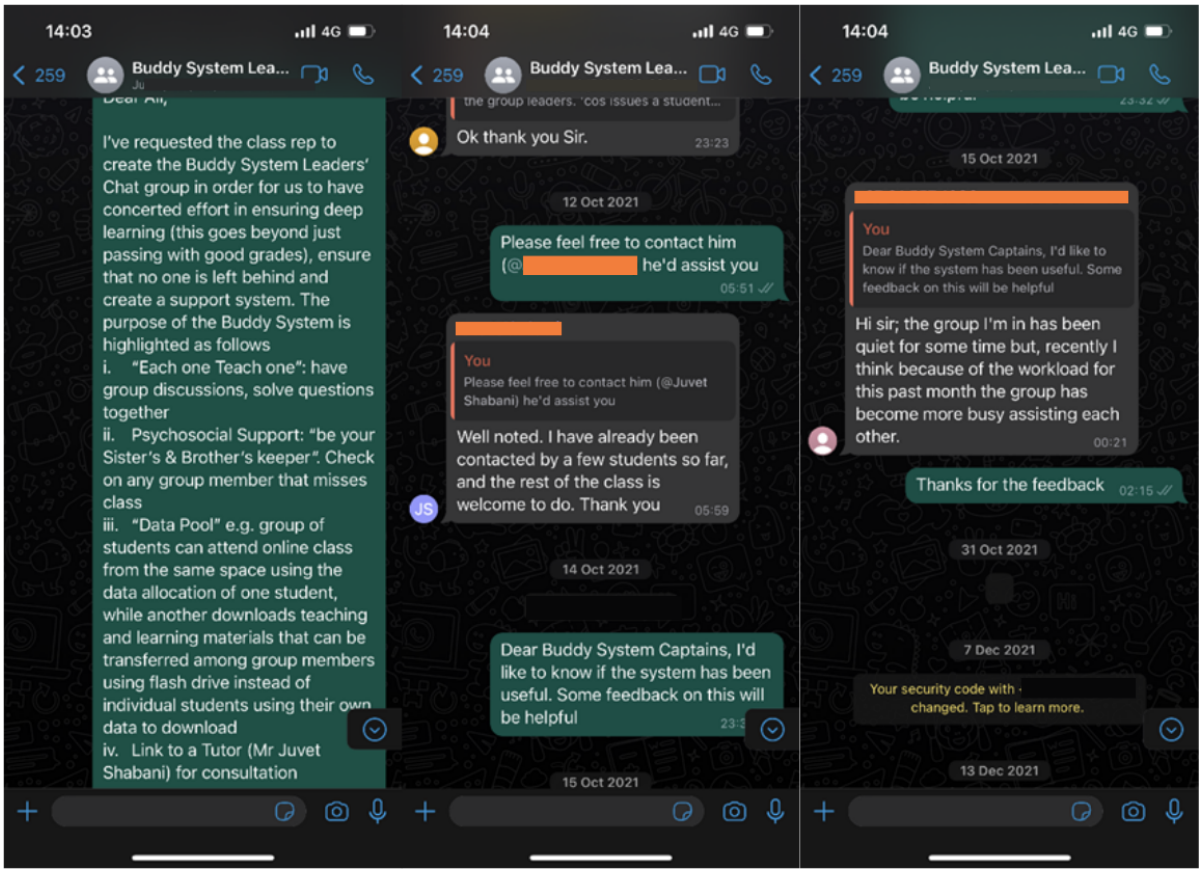
Collaboration

Students are placed in groups to conduct group projects to facilitate collaborative dialogue. A cyclical movement between the learner's concept and practice is facilitated. As with the discussion process, this approach is underscored by social constructivism which promotes learning as a social process and the dependence of all cognitive functions on interactions with others (Oyekola, 2020). This was actualised in two ways: (1) using the Buddy System and (2) through the group projects (which will be discussed later in the production section).

The Buddy System presented a more informal, semi-structured approach for collaboration throughout the course while the group project was a formal summative component of the course. Although the Buddy System is a form of collaboration, it goes beyond this learning type into the essence of forming a community within a course. The class was divided into groups of 10 students and a leader was appointed per group and given access to an associated WhatsApp group. The leaders were tasked with the responsibilities of coordinating their groups to facilitate improved motivation, enhanced productivity, enhanced engagement, improved teamwork, and more effective management (Figure 5) (Oyekola, 2020). In many ways, the Buddy System facilitated several of the other learning types, especially inquiry and discussion.

Figure 5

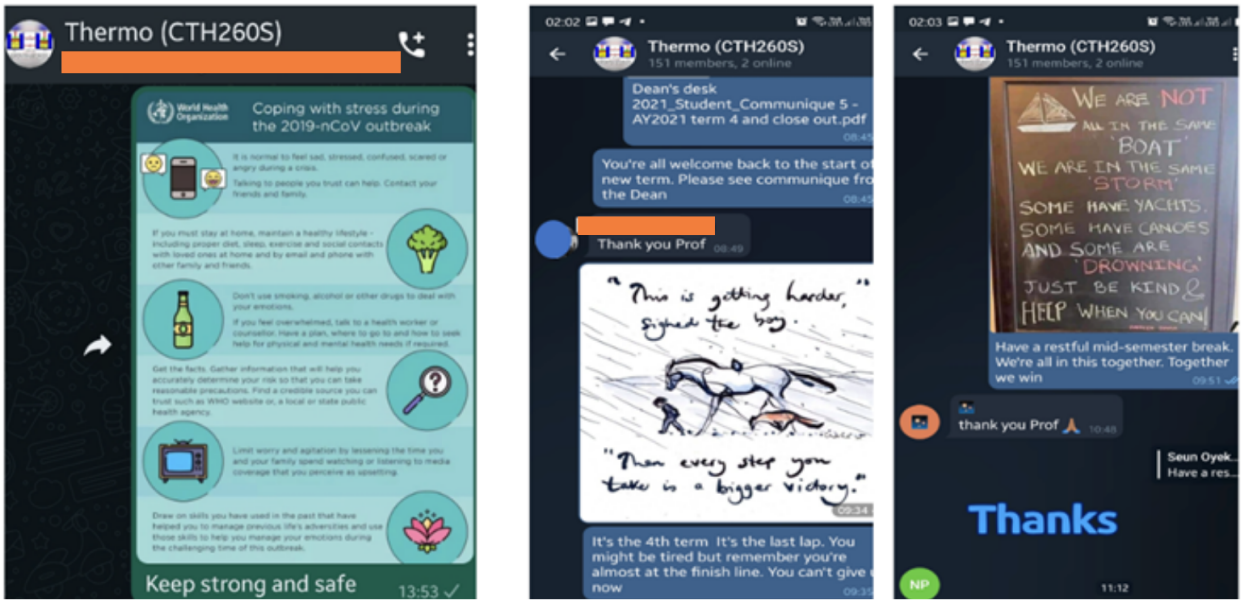
Screenshots of WhatsApp group discussion with the Buddy System leaders



As a lecturer, I was not directly a part of the Buddy groups, instead, there was an additional WhatsApp group for the lecturer and group leaders (Figure 6).

Figure 6

Psychosocial support from the lecturer on WhatsApp and Telegram



The Buddy System had three aims - to enable collaborative learning, psychosocial support and data pooling.

"Each one, teach one": The Buddy System created opportunities for learning through discussion and collective problem-solving.

The "Buddy System is grounded in constructivist understandings of learning where collaborative construction of knowledge is mediated by making students work in groups. Following the constructivist theory, "the role of teachers is not to dispense knowledge but to serve as a creative mediator and facilitator to provide learners with opportunities and incentives to construct their own perception of reality" (Emami, 2009, p. 3).

Psychosocial support: The Buddy System enabled greater psychosocial support within groups.

The pandemic was a particularly isolating time for most people. For students, living at a distance from families and among people with whom they did not have close social networks, the pandemic was particularly psychologically harmful. Many scholars in different contexts globally have written about the impact of the pandemic on feelings of connection and belonging (see for example, Phillips et al., 2022, Padmanabhanunni & Pretorius, 2023).

Data pooling: The Buddy System enabled the sharing of data and devices.

In their private residences, some of which are in rural areas or urban areas with poor infrastructure development, students would have had very limited access to the internet. However, as students were permitted to return to campus in small, controlled numbers, many would have returned to their term-time accommodation. For students in official campus accommodation, access to the internet would have been provided by campus wifi. However, many of our students would have returned to private, term-time accommodation such as apartments and privately-run student hostels. In these cases, while the internet is available, it remains an expensive item. In cases where small groups of students had physical access to each other in their term-time residences, they could, and did, attend online classes from the same space, using the data allocation of one student while another student downloaded learning and teaching materials. Materials could then be shared among group members using flash drives, thus reducing data costs. While these are by no means high-tech solutions to the problems, students were able to continue learning despite constraints such as limited data or unsuitable devices. Furthermore, this interdependence created a sense of camaraderie among students, creating a sense of belonging for students who were experiencing the lockdown within proximity to one another during a time characterised by extreme loneliness and isolation.

It is evident that these efforts appear to have had at least some effect. For example, one student noted that they were quite close with their group and that the space was used for motivational messages to support one another.

Production

Students are expected to articulate their learning activities by producing something for the teacher to evaluate. On completing the group projects, students are expected to present their findings both verbally using presentation tools and in written formats. This is the converging point of the previous learning types. Cognitivism and constructivism learning theories come to the fore herein. In this case, the learning activity type was actualised in a project integrated with the subject of Thermodynamics. ECSA requires engineering students to produce artefacts or polished products throughout their course of study (Moothi, 2023). Conventionally, in the project and laboratory subjects integrated with thermodynamics, as in other engineering courses, students create design artefacts ranging from sketches and drawings to prototypes. Subject integration as employed herein mirrors real-world problems (i.e. authentic learning), emphasising comprehensive understanding, work-preparedness and the connection of theory to practice (Herrington et al., 2010).

Key design choices

Laurillard's learning types offer educators a framework for focusing their teaching practice and design on students' activities rather than their own; this is useful for novices or less experienced educators. Thinking through the six learning types can encourage a shift away from well-established or even entrenched teaching practices such as extensive lecturing which can limit students' learning activities to more passive formats.

Upon reflection, it was clear that there are limits to designing with Laurillard's learning types especially with creating connection and community. While learning types are a powerful tool for creating varied and responsive designs, the framework does not explicitly offer guidance on the creation and guidance of connection and community. In my context, both connection and community in the classroom are difficult to establish and maintain and this was exacerbated during the RTL process. In this section, I reflect on three key design choices which Laurillard's learning types do not address.

Knowing your context

Learning design frameworks often place substantial importance on grounding design work in an understanding of students and lecturers who will experience the design. In conventional process models such as ADDIE and ASSURE, this takes the form of an "analyse" stage (Bajracharya, 2019). In more design thinking oriented models, understanding the "users" of a design might be captured under the concept of empathy (Khan et al., 2022). While definitions of empathy vary, for the purposes of this paper, I understand empathy to be a "complex set of reflexive psychological characteristics associated with social intelligence, emotional literacy, mental state", which allows "us to see and sense the viewpoints of others" (Elfilti & Gelmaz, 2023, p.2). Given the rapid contextual changes, and the already vulnerable situation of many of our students, I felt it prudent to engage with both students and staff to better understand the context I was now designing for.

At the end of the second semester in October 2020, I approached both students and lecturers in the Chemical Engineering department to explore their understanding of the challenges faced by undergraduate students during RTL. I surveyed both staff and students on their experiences of RTL across various courses in the department. This section presents key outcomes from the survey with staff and students, highlighting the outcomes of the course design.

Some students expressed a strong preference for face-to-face learning, saying: "Physical interactions are better than online learning" and more expressively: "Remote learning is depression itself". Another student described online classes as "so stressful; all modules have basically become self-study which has made it nearly impossible to cope". Many of their comments pointed to a sense of missing connection characterised by strong affective elements.

Ten lecturers, a substantial group in my department, reported noticing a heightened sense of anxiety among their students. A lecturer noted that:

> *Adopting RTL during COVID-19 created sudden shock for both the students and the lecturers. To adapt to the shift requires time, most especially to the students. Teaching approach (instructor directed, interactive and/or collaborative session) where students ask questions via e-mail and or WhatsApp was implemented, knowing that students are drivers of their own learning. The effectiveness of this approach can only be substantiated upon collection of more data, due to variations in the students' cognitive capacity, considering the background of the students. RTL can be the future if well implemented.*

As I moved through the RTL, I actively sought to create opportunities for connection and community with and between my students.

Building community online

Building community in face-to-face classes is often something that lecturers leave at least partially to chance. In this context, a sense of community develops over time, actively, as students engage with their peers, tutors and the lecturer and passively as they observe engagements between the lecturer or tutors and other students. Opportunities to strengthen this potential community surface during formal lectures, tutorials and in individual interactions. The onset of the pandemic and the accompanying restrictions overturned the largely tacit and ad hoc processes of face-to-face community building. Furthermore, the pandemic entirely disrupted the ways in which the classroom community has historically gathered, requiring a deliberate and considered strategy for developing community. I undertook a number of strategies to build community online, which I will discuss briefly below.

The Buddy System, which I have discussed already, is a strategy I used to build not only a suitable context for learning, but also, critically, community among students. As Ngubane et al. point out (2022), working in groups is a graduate requirement for engineers and, as is widely discussed in the literature (see for example, Laurillard, 2012) a key practice for cultivating critical thinking and psychosocial support.

Prior to the pandemic, tutorial sessions were conducted for the entire class as one big group. Although in these large groups, there is a tendency for some students to be lost in the crowd, there were also opportunities for serendipitous individual conversations and interactions. Such informal, serendipitous connections seem to be less likely in online learning environments (Kop, 2013) and require deliberate design. Many students are more comfortable expressing themselves in smaller groups such as WhatsApp groups. During the pandemic, given the isolation from their peers, it became even more essential to create a classroom environment where students could connect with each other and feel comfortable to ask questions or seek support as needed. The psychosocial and community support were central to the design of my course and went beyond the cognitive aspects of the learning types.

Building connection through teacher presence

While most learners indicated their need for a lecturer's presence, many lecturers did not make provision for this. In the feedback on the earlier part of RTL, a student pointed to a sense of disconnection from their lecturers during this time describing learning as "basically becoming self-study which has made it nearly impossible to cope". While lecturers understood students to be the "drivers of their own learning", students experienced this as a lack of lecturer presence. The initial recommendations at the time advocated for the use of tools that were maximally accessible to students with limited data and that allowed for flexible access across the day. This led to asynchronous approaches to teaching and learning. Most lecturers used, as per recommendations, asynchronous teaching tools within the LMS augmented by WhatsApp for interaction. Only three lecturers indicated that they had actively sought to create an online equivalent to the face-to-face teacher's presence.

Anderson et al.'s (2001) work on the notion of "teaching presence" defined it as "the design, facilitation, and direction of cognitive and social processes for the purpose of realising personally meaningful and educationally worthwhile learning outcomes" (2001, p. 5). I worked on strengthening teaching presence in several ways. I have already discussed the Buddy System which provided a distributed form of teaching presence through the group leaders without my direct involvement in the groups. In addition, I used several direct strategies, including introducing myself at the beginning of the term, offering lecture summaries, instructor-authored resources, weekly announcements and prompt feedback through the LMS. By creating my own videos, students were able to hear and see me regularly, creating a sense of direct teacher presence that was personal and embodied.

To find out how they were handling the situation, I often checked in with students on WhatsApp and Telegram (Figure 6 and 7). My go-to phrase was "we are all in this together." Students indicated a clear appreciation for a strong teacher presence:

> *I genuinely appreciate Dr Oyekola. I feel he really cares and listens to us. There are very few lecturers in our department who have been empathetic throughout this time and he is one of them. It makes me want to join his classes and do the work.*

Teacher presence is clearly necessary for students' sense of confidence and their sense of being cared for (Ebersole, 2021), and given the demands of the moment, were key aspects of working responsively with my students.

Tools choices for learning types

The learning design literature offers several concepts, tools and frameworks for choosing the technologies and tools that constitute the digital environment of the course (Bower, 2008). These have shifted over time with the earlier frameworks tending to prescribe the use of specific tools for specific purposes and others focusing on, for example, the capacity to "scaffold progressive inquiry", the provision of tools for "structuring and coordinating activity" and supporting community building or focusing on pragmatic factors such as "student rating" or "cost" (Bower, 2008, p. 4).

More recently, with renewed concerns about the barriers experienced by black students, students from low-income backgrounds and students with disabilities, accessibility, useability and inclusive design are receiving greater attention with tool selection and tool design (Phillips & Colton, 2021).

For this paper, I focus on the technologies and tools that are student-facing and omit those that are used in the production of materials or course administration activities that are not student-facing. I primarily chose tools and technologies that students were conversant with such as WhatsApp, Telegram and YouTube; I supplemented these with the most accessible versions of tools fit for purpose such as Zoom for video conferencing.

Synchronous lectures and feedback sessions were held on Zoom. We did not make full use of the allocated face-to-face time (six periods, equivalent to four and a half hours per week) to avoid online learning fatigue. The maximum time used for synchronous engagement was 80 minutes per week and the rest of the time was allocated to asynchronous activities.

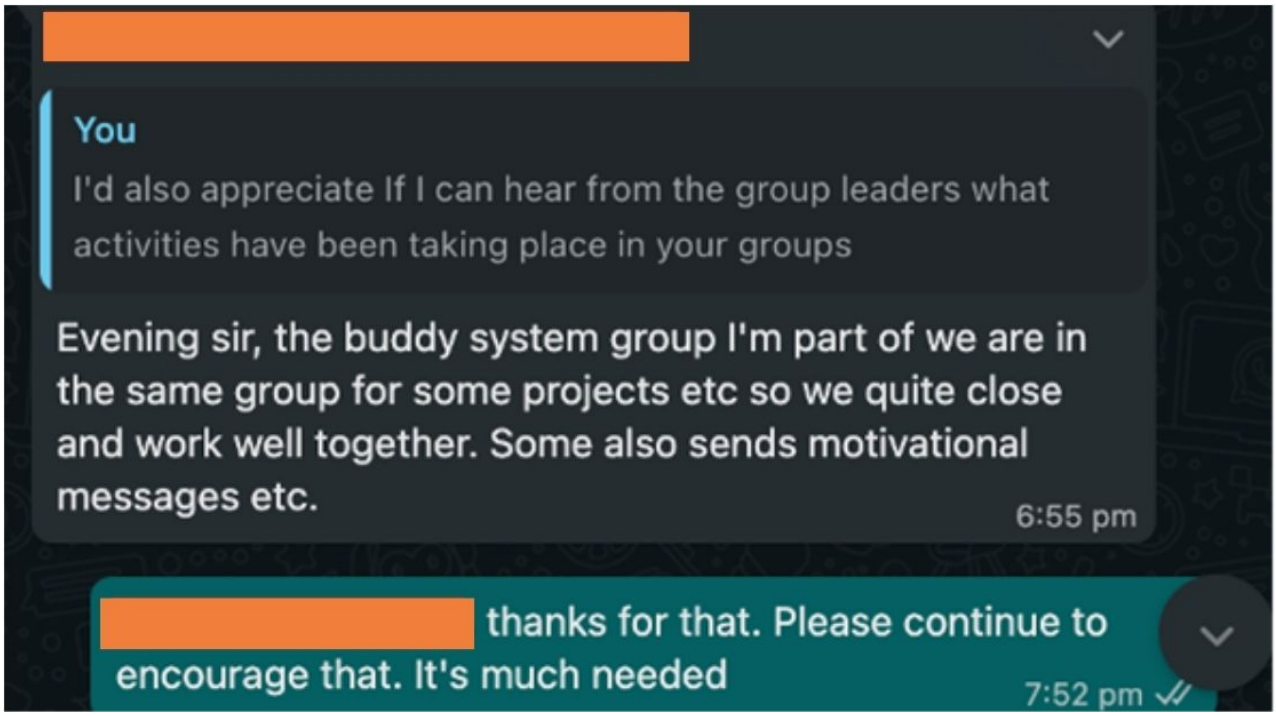
Initially, discussions were held and announcements were posted on WhatsApp. We later migrated to Telegram since it accommodated a larger group, permitted the sharing of any type of media and allowed file sizes of up to 1.5 GB. Students joined the group at different intervals and unlike WhatsApp, students could view past posts at any time they joined the Telegram group.

All the tools were embedded or linked to the LMS to maximise access and allow for class scheduling and emails. Short YouTube videos were downloaded and uploaded on the LMS. Quizzes were set up on the LMS to assess students on the completion of each chapter. This encouraged the students to study immediately and afforded them timely feedback.

Aside from using existing videos, I created a YouTube channel where I uploaded videos of me teaching key concepts (Figure 7).

Figure 7

Screenshot of personal YouTube channel



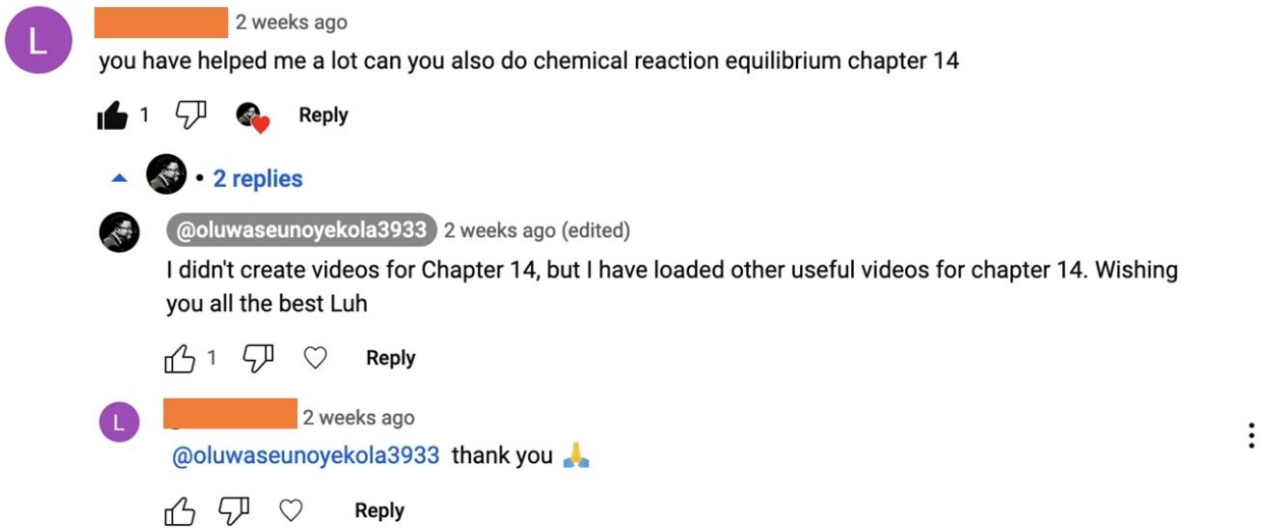
Rambe and Ng'ambi (2011) stated that:

> *real life experience blends both formal and informal knowledge. Unlike LMS collaborative tools such as discussion boards and chats, which learners often conceive as provided by the institution and open to educator manipulation and regulation, learners usually perceive Facebook as a technology in their control (p. 62).*

This can also be said of YouTube. Students were able to post comments and queries without the fear of censorship. Students can also use pseudonyms which they cannot do on the LMS. Contents on LMS are typically removed by the University's information technology unit at the end of each session to create space for subject contents in the subsequent session. There is no such limitation with YouTube. While the videos were created during the pandemic period, learners still currently have access to the videos and can continue to ask questions on the channel, (Figure 8), effectively creating an ongoing community resource.

Figure 8

Screenshot of interaction with a student on my personal YouTube channel two years post-publishing



Conclusion

In my context, the COVID-19 pandemic drove substantive changes to teaching and learning - specifically, the shift towards online learning in chemical engineering education. Unfortunately, the urgency of the situation left minimal time for well-planned learning design. The presented case study delves into the emergent design that resulted in the rapid transition from predominantly face-to-face instruction to the online platform. This shift required adopting interventions, necessitating a closer analysis of the challenges and the strategies employed. Adopting Laurillard's framework offered a structured approach to learning design, albeit with ad hoc implementation and some limitations. The experience made clear how important it is for academics and learning designers to close the gaps in remote learning. The development of various artefacts and activities that cater for multiple learning types for a diverse group of students within the constraints dictated by the context also came to the fore. Further, it provided the opportunity to be proactive by envisaging possible concerns before deploying the tools and resources, while also regularly evaluating the usefulness of tools and resources.

This transformative journey experience facilitated a thorough understanding of the multifaceted roles of an educationist as a teacher, researcher and designer in creating authentic teaching and learning experiences. The incorporation of innovative learning design approaches is evidence that transformative learning is possible in the face of unexpected

challenges. The knowledge obtained from this study contributes to the ongoing conversation about effective teaching and learning strategies in the digital era as we continue to navigate the changing terrain of remote learning and teaching.

The case suggests that, in the conventional mode of content delivery, we may have spent too much time with students in the acquisition learning type. This orientation to a didactic mode is more teacher-centred and encourages dependence on the lecturer. The proverb “necessity is the mother of invention” seems to have driven innovative learning and teaching because of the imposed constraints. In the current “normal” context we should proactively impose some constraints, for example, less time on didactic teaching and more on coaching and on the curriculum. The curriculum needs careful and regular revision and redesign. Learners and teachers need a paradigm shift: the incorporation of flexibility and student agency into learning and teaching is inevitable in the current landscape.

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Oluwaseun Oyekola

Cape Peninsula University of Technology

Oluwaseun Oyekola is an Associate Professor in the department of Chemical Engineering, Cape Peninsula University of Technology, South Africa, where he also serves as the postgraduate studies coordinator. He holds a PhD in Chemical Engineering from the University of Cape Town, South Africa. He links teaching and learning with research and scholarship, with emphasis on national relevance and global excellence. His scientific research interests include resource recovery from waste materials, renewable energy and bioremediation of wastewater. His research in teaching and learning addresses the issue of social justice. He has over 90 publications in peer-reviewed academic journals, conference proceedings and other knowledge hubs.