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Flexible curriculum design for quantitative skills development: Building on the insights gained during COVID-19

Abstract

Before the COVID-19 pandemic, technology-enhanced learning and its relation to student engagement, and the necessity of good student-staff relationships for creating a successful education environment were evident. The COVID-19 pandemic forced higher education to adapt to a challenging technology-led learning environment that demanded, inter alia, high levels of flexibility and human-centredness. Valuable lessons were learned that highlighted new perspectives on curriculum design and delivery in a normalised, technology-driven environment. Against the background of COVID-19-related literature on teaching and learning, the authors reflect on their insights regarding curriculum design and delivery of two quantitative skills modules during the COVID-19 pandemic, and its impact on further curriculum planning. The focus of the article is on the intentional flexibility built into curriculum offerings during 2020-2022. The study reviewed flexibility on three levels, namely student, facilitator (staff) and delivery levels, through a multi-method research methodology. Quantitative data related to the academic performance of 2 949 students enrolled for the two quantitative skills modules from 2020 to 2022. Qualitative data related to themes through thematic analysis of student and facilitator surveys, focusgroup discussions and semi-structured interviews. The improved student academic performance reported by the study could be attributed to, amongst other factors, 1) flexibility of the selected delivery option, 2) positive staff and student experiences and engagement, and 3) intentional inclusion of activities promoting student-staff relationships. The good academic results obtained during the pandemic led to important curriculum decisions for a normalised future for these modules, which will be built on flexibility and human-centredness. Among these decisions is to continue presenting the modules in an online environment, even though traditional face-to-face teaching options are available.

Keywords: *flexibility, quantitative skills development; student engagement; staff-student relationships*

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1. Introduction

Technology-enhanced learning was present in higher education settings long before COVID-19 broke out, with different levels of integration between online and face-to-face learning and teaching interactions. Such blended interactions include a wide range of activities (e.g. in-class quizzes, discussion forums/boards, open educational resources, podcasts, and self/peer assessment) on a continuum of asynchronous to synchronous learning (Serrano et al., 2019). Bond, Bedenlier et al. (2020) found, in a systematic review of education technology in the field of education, that two applications of education technology in higher education are prominent, namely 1) "using technology to enhance communication and social exchange" and 2) "using technology for self-directed learning". From these findings of the review of Bond, Bedenlier et al., it is evident that, before the COVID-19 pandemic, the use of technology in education was seen as an *adjunct* to face-to-face learning. However, the move to online learning as the only mode of delivery during the COVID-19 pandemic rapidly changed the perception of technology in education from it being *adjunct* to it being *central*, which demands changes to the normal way of thinking and doing by both staff and students. Currently, higher education teachers are faced with the challenge of moving beyond COVID-19-related (emergency) online teaching, towards a high-quality, human-centred, post-COVID-19 learning environment. The literature, as discussed below, provides valuable insights, but should be integrated with evidence from the pre-COVID-19 and COVID-19 periods for specific courses (or modules as used in this article), to create directives for the anticipated future.

The aim of this article was to provide insights into curriculum design and delivery in two quantitative skills modules for business students presented at a South African university. During the review period of 2020-2022, these quantitative skills modules had to be adapted continuously to adjust to the varying restrictions of COVID-19, and to accommodate the implementation of the Carnegie Math Pathways (hereafter called Pathways) at the university (see Figure 1).

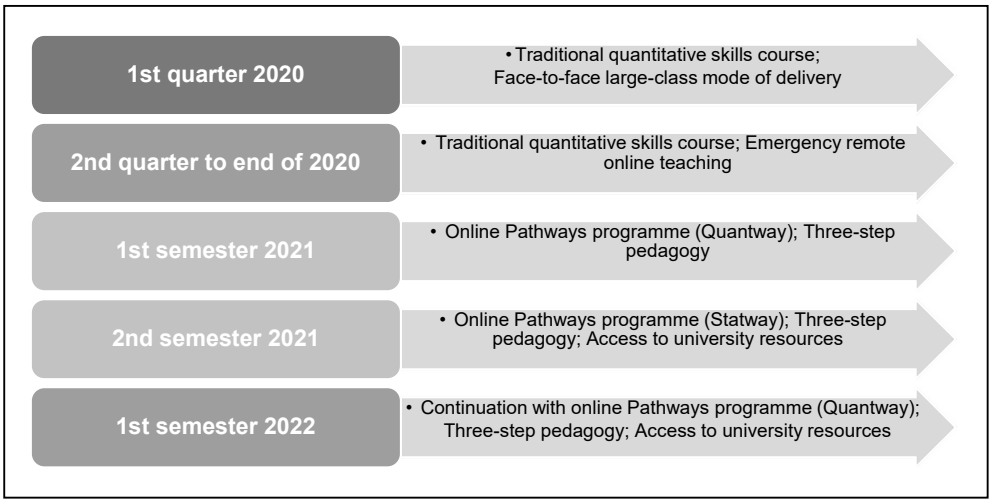

Figure 1: Curriculum design and delivery of two quantitative skills courses from 2020 to 2022

As portrayed in Figure 1, the traditional module was presented as a large-class face-to-face module pre-COVID-19. With the implementation of the COVID-19 lockdown in March 2020, the traditional module was moved to an asynchronous, online environment. Opportunity for engagement with tutors and other students enrolled in the module, was facilitated through asynchronous, online discussion forums. In 2021, the Carnegie Math Pathways modules (i.e. Quantway in the first semester and Statway in the second semester) were implemented. Due to the continuing COVID-19 restrictions, it was presented in an online environment. Engagement with module content included both synchronous and asynchronous learning activities. Individual class preparation activities and exercises are completed by students individually and asynchronously. Four hours per week were dedicated to online, synchronous activities. These included full-class as well as small-group collaborations. During the full-class collaboration, groups of 50-60 students met in an online classroom, where the facilitators introduced the unit concept and context. Thereafter, students moved into smaller online classrooms with 3-5 students, where they collaboratively completed the class activities. Facilitators moved between these small groups to assist with discussions and questions, as necessary. All these asynchronous and synchronous learning activities are assessed online and contribute to the final module mark. With the easing of COVID-19 restrictions, all students could return to campus from the beginning of 2022. Although all students returned to campus, which provided the option to revert to a face-to-face delivery, the benefits of small-group collaborations in a large class context (i.e. with more than 500 students registered for module/s) the decision was made to retain the online delivery, utilising the asynchronous and synchronous activities, as explained above. Students who had challenges with access to electronic devices and/or data could now utilise university resources to access their online module/s. Further flexibility was embedded in the design through allowing students to complete and submit their small-group collaboration activities synchronously outside of the dedicated class time (i.e. as arranged amongst themselves), due to external challenges such as loadshedding.

The Pathways programme was launched in the United States in 2010 to transform the quantitative skills learning experience of students in the international higher education environment. The aim of Pathways is to accelerate students' academic progress, improve student success, while improving the content and pedagogy of quantitative modules (WestEd, 2022). The programme focuses on, among others, on relevant and innovative curricula, socio-emotional student support, providing a variety of instructional materials, and continuous professional development of staff. Ultimately, Pathways develops quantitative reasoning and problem-solving skills supporting everyday decision-making (WestEd, n.d).

Towards the end of the article, the data of our study will be integrated with relevant literature (as described in the next section) to provide directives for future curriculum design and delivery of quantitative skills modules in a post-COVID-19 environment.

2. Perspectives from COVID-19-related teaching and learning literature

For moving beyond COVID-19, authors propose an integration of strategies to optimally leverage the strengths of the face-to-face, blended, and online environments, and to create a high-quality, human-centred higher education environment. These strategies focus strongly on student engagement and education technology (Brown, 2021; Hill & Fitzgerald, 2020; Neuwirth, Jović & Mukherji 2021), student-staff relationships (Snijders et al., 2020; Whelehan, 2020), flexibility in curriculum design and delivery (Hill & Fitzgerald, 2020), equitable resourcing and educational technology (Mac Domhnaill, Mohan & McCoy, 2021; Salas-Pilco,

Yang & Zhang, 2022), and continuous student and staff development in an adapted learning environment (Bond, Buntins et al., 2020; Ghani & Taylor, 2021; Neuwirth et al., 2021; Salas-Pilco et al, 2022).

Figure 2 presents a summary of the strategies proposed in COVID-19-related teaching and learning literature and used as the theoretical basis of this article. These strategies include student engagement, student-staff relationships, flexibility in curriculum design and delivery, staff and student development and equitable resourcing. Each strategy will be unpacked in more detail in the rest of this section.

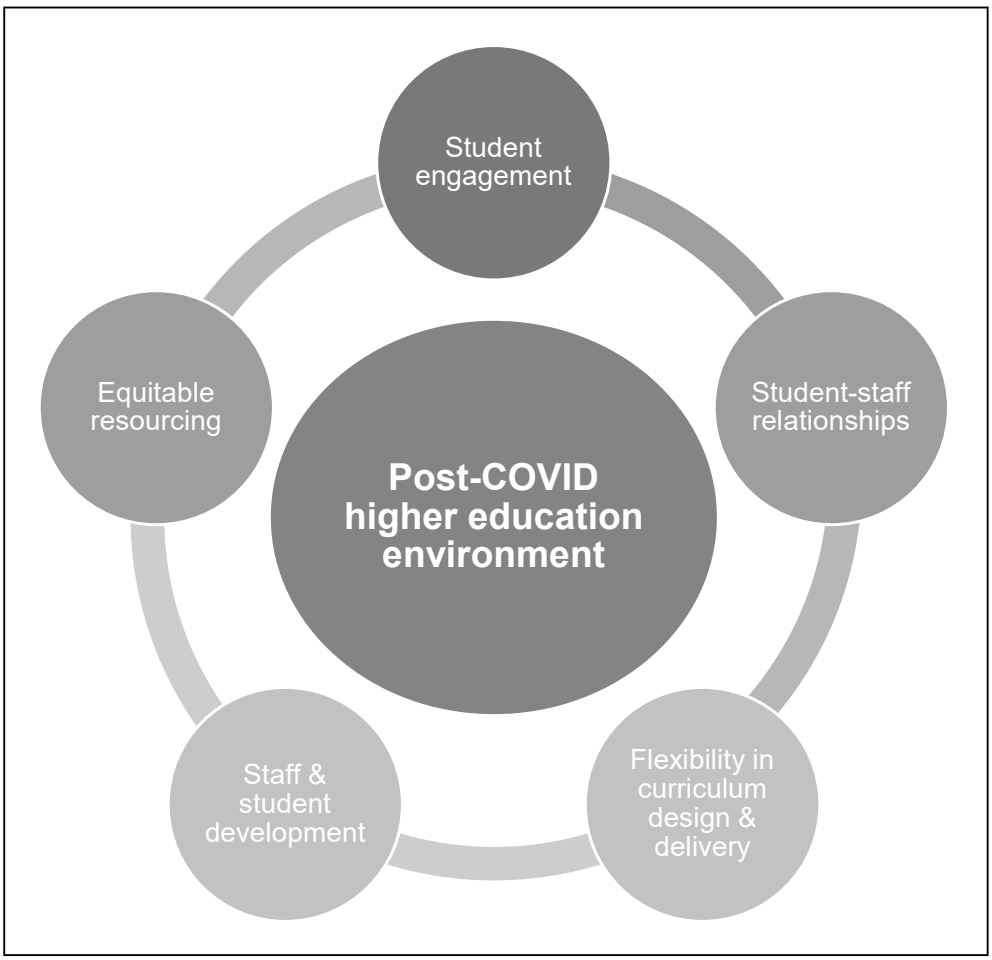

Figure 2: Strategies for a high-quality, human-centred higher education learning environment when moving beyond COVID-19

Several authors explored student engagement and education technology during the COVID-19 pandemic. Most of the authors reviewed **student engagement** in three domains, namely cognitive student engagement, behavioural student engagement and affective student engagement (Bond, Bedenlier et al., 2020; Bond, Buntins et al., 2020; El-Sayad, Saad & Thurasamy, 2021). Behavioural student engagement is the dimension of student engagement

reported on most often, and includes facets such as participation, achievement, confidence, study habits and attention/focus (Bond, Buntins et al., 2020). Regarding cognitive student engagement, Bond, Buntins et al. (2020) include learning from peers, deep learning, self-regulation, positive self-perception, and critical thinking, whilst affective student engagement includes positive interaction with teachers and peers, enjoyment, positive attitude relating to learning interest, motivation, and enthusiasm (Bond, Buntins et al., 2020). Disengagement factors, on the other hand, include anxiety, frustration, pressure, feeling overwhelmed, disinterest, and being distracted (Bond, Buntins et al., 2020), which can easily be linked to emotions possibly experienced by students (and staff) during the COVID-19 pandemic.

In moving towards a high-quality post-COVID-19 educational environment, the following strategies could enhance student engagement:

- Learning should be a social endeavour, supporting more positive interactions with peers and teachers, and increasing enjoyment of learning (Bond, Bedenlier et al., 2020).
- Students' knowledge and skills in relation to technology should be taken into consideration, and students should be provided with adequate support and development in this area to prevent frustration, which could lead to disengagement (Bond, Bedenlier et al., 2020).
- Collaborations, in the form of communities of practice, lead to better engagement and improve feelings of connectedness, confidence and enjoyment (Bond, Bedenlier et al., 2020).
- Academic self-efficacy can be linked to better behavioural and emotional engagement (El-Sayad et al., 2021), and should, thus, be promoted by teachers.
- Perceived usefulness of learning content influences emotional and cognitive student engagement (El-Sayad et al., 2021) and should be considered by teachers in both curriculum development and delivery.
- Teacher presence influences all domains of student engagement (El-Sayad et al., 2021) and should be included purposefully in teaching and learning.
- Student partnerships should be created (Whelehan, 2020), as it could lead to positively engaged and loyal students (Snijders et al., 2020).
- Resource equality supports the use of technology in learning and may create positive attitudes towards learning (Baloran, Hernan & Taoy, 2021).

Student-staff relationships were another important aspect explored in literature published during the COVID-19 pandemic. Wester et al. (2021:9) fittingly report the following:

> Despite these logistic and pedagogical difficulties, when asked to describe a memorable moment of teaching online during the pandemic, faculty [teacher]) often recalled getting to know their students on a more personal level, as well as purposeful acts of kindness and empathy, either by students or by the faculty themselves.

This view is supported by Hall (2020), who argues that the COVID pandemic forced teachers (and students) to re-evaluate their positions within the academe, as involving a focus on work, rather than on themselves, and that this new focus could influence student-staff relationships moving forward. This focus shift might also provide some clarification why Gourlay et al. (2021) found that students valued live (or synchronous) learning during the pandemic, as it provided a feeling of connectedness, and an opportunity to socially construct their (deep) learning with others. Students in this study furthermore reported feeling that they became

"members" of the learning experience, rather than being "spectators" (Gourlay et al., 2021). Research on online teaching and learning during the COVID pandemic highlighted the notion of *avogogy* previously described by Cheney and Bronack (2011) as a dimension of presence pedagogy. According to these authors *avogogy* describes the creation of formal structures and approaches to combine "presence-rich environments and appropriate online instructional facilitation toward supporting growth, development, and learning" (Cheney & Bronack, 2011:3 of 7). Some practices that might enhance presence pedagogy in the online environments, and that can be linked directly to our study, include that both peers and "experts" (facilitators in our case) serve as catalysts to learning, students share personal and/or professional experience (when completing the collaborative learning activities in our case), students engage in a "community of practice" (or small-groups in our case), activities that utilise "distributed cognition" (when completing the collaborative learning activities in our case), and utilising learning materials that have relevance for the learners (through a mix of international and contextualised content in our case) (Cheney & Bronack, 2011:2-3 of 7). This deliberate focus on presence pedagogy could be significant for teachers when they move beyond COVID-19, as the previous, more transactional (or traditional) nature of learning could have influenced student engagement negatively as seen in poor face-to-face class attendance (reported pre-COVID), or limited online participation (in blended learning environments pre-COVID). The improvement in engagement, through embedding the principles and suggested practices of presence pedagogy into the post-COVID online/blended classroom, could then ultimately inform more flexibility regarding curriculum design and delivery.

Zhao and Watterston (2021) suggest three important changes to be made post-COVID to ensure more **flexible curriculum design and delivery**, namely 1) Curricula that evolve and are personalised; 2) Pedagogy that is student-centred and purposeful; and 3) Delivery that incorporates the advantages of both synchronous and asynchronous learning. These suggestions link to positive student engagement factors and student-staff relationship factors (as mentioned above) and include, amongst others, improving the perceived usefulness of learning material, and ensuring students become members of the learning process. To create more flexible curricula, as suggested by Zhao and Watterston, additional **student and staff development** is required. Brown (2021) warns against staff trying to replicate face-to-face teaching in an online environment, which is an important consideration moving forward, and highlights the importance of staff development for moving to a high-quality, human-centred learning environment. Even though support was provided to staff during the initial transition phase to an online mode during the pandemic, some concerns were raised regarding the support provided to students in the initial transition stage to help them navigate their learning in an online environment (Neuwirth et al. 2021). This failure could have caused some of the frustrations raised by students during the pandemic, as alluded to by Bond, Bedenlier et al. (2020).

In addition to frustration about technology-enhanced learning due to students' varying levels of knowledge and skills in relation to technology, frustration was also evident amongst students in relation to **(in)equitable access to resources**. Baker et al. (2022) explored the possibilities for engaged pedagogy post-COVID in a culturally and linguistically diverse population. They acknowledge the positive aspects of online teaching during the pandemic, such as the flexibility of expectations of students (regarding assessment, for example) and deep concern of teachers for the well-being of their students. However, the study also found that the online teaching mode highlighted the difficulties of some students regarding certain

aspects, such as problems with internet connectivity, disengagement, poor time management and personal difficulties related to studying in their home environments (Baker et al., 2022). These authors argue that, through careful curriculum design, the flexibility linked to blended learning could provide greater opportunities for students to engage in their learning in accordance with their unique needs (and challenges), which has not been the case in the more rigid system known before the pandemic.

3. Research context

The lessons shared in this article are related to two quantitative business skills modules presented at a South African university. As portrayed in Figure 1, the first set of data originates from the traditional pre-COVID-19 modules presented in a face-to-face mode (more than 500 students registered). With the implementation of the hard lockdown in South Africa towards the end of March 2020 (i.e. end of the first quarter of 2020), the traditional module was moved to an online environment. In this online environment, teaching and learning were mostly facilitated through large-class discussion sessions with tutors, peers and/or teachers (according to the lecture timetable of the pre-COVID-19 time), self-study of learning material made available on the learning management system, voluntary online consultations with teachers (when needed), and online assessment. Due to challenges related to access to data reported by students, Virtual Private Network (VPN) (global) access to university systems was provided to students, which gave them free access to data on particular URLs.

In the first semester of 2021, the Pathways Quantway Core (hereafter called Quantway) module was introduced in an online environment to replace the traditional module. Students still had access to the VPN (global), allowing them to access the online platform(s) through which the new Quantway module was presented. The pedagogy of the Pathways programme was significantly different to that of the traditional module (as mentioned above). In the Pathways Quantway module, students followed a three-step pedagogy that is: 1) Preparation exercises that had to be completed individually before; 2) The collaboration (or synchronous small group contact session); 3) Followed by exercises to monitor each student's understanding of the unit. Formative and/or summative module assessments, like those included in the traditional module, were maintained to determine student performance in the module. The pedagogy employed in the Pathways programme allowed for small-group discussions in a large-class setting, though online, which differed from the large-class discussion opportunities afforded in the traditional module (see Figure 1).

In semester 2 of 2021, the second module of the Pathways programme (i.e. Statway College, hereafter Statway), which applied the same three-step pedagogy described above, was introduced in an online learning environment, to replace the traditional quantitative skills module previously (before COVID-19) presented to business students. During this semester, first-year students in the faculty were allowed to visit the campus to use on-campus resources such as computer laboratories and the university Wi-Fi network. Students who did not return to campus still had the VPN (global) access to the online learning platforms and/or URLs.

In 2022, the Faculty of Economic and Management Sciences continued with the Pathways programme in an online learning mode, even though all students had the opportunity to return to campus and make use of the university resources (see Figure 1).

The research methodology employed to reflect on the curriculum design and delivery in these two quantitative skills modules are described in more detail below.

4. Research methodology

To review the curriculum design and delivery of the two quantitative skills modules from 2020 to 2022, mixed methodologies which included quantitative and qualitative data were employed. Quantitative data focused on the academic performance of the 2 949 students who were enrolled for the two quantitative skills modules from 2020 to 2022 (see Tables 1 and 2). Quantitative analyses of data included correlation analysis, bivariate regressions, and analysis of variance to determine the impact of a flexible, online curriculum on student academic performance within a large class context.

Proximity and related researcher bias are acknowledged as possible limitations of this study with qualitative data analysis. To limit such possible biases several strategies were employed. Firstly, qualitative data were obtained through voluntary participation in surveys and semi-structured telephonic interviews, and anonymous verbal feedback (in the form of WhatsApp® voice notes) by students. Further, all telephonic interviews were conducted by an independent interviewer to limit bias in responses, as the researchers are involved in the implementation and management of the quantitative skills modules. Surveys were conducted online to ensure that responses were anonymous and could not be linked to any specific student and/or teacher (facilitator). Thirdly, qualitative data were analysed using a process of thematic analysis to identify themes. The analysis was performed independently by the researchers, whereafter it was discussed to ensure rigour in the process of identifying the themes. Lastly, qualitative data in this study were triangulated with the objective, quantitative data to provide a more in-depth understanding of the trends noted in the quantitative data. The findings are evaluated at the end of each semester through a validation meeting between the researchers and the Pathways stakeholders in the United States. During this meeting, the researchers' quantitative findings are compared with the independent quantitative analysis performed by Pathways.

Before commencement of the study, ethical approval for the study was obtained from the university's General and Human Research Ethics Committee (GHREC) with ethical clearance number UFS-HSD2020/1111/144/21. Participants agreed to participate voluntarily in the study and written or verbal consent was obtained from each participant prior to data collection. Participants could withdraw from the study at any time without penalty.

5. Results and discussion

The study included all students who were enrolled in the two quantitative skills modules mentioned in this article (n=2 949). The 2020 content, pedagogical approach and results served as a baseline for the results of the following years – after implementation of the Pathways programmes in 2021 (see Figure 1). Table 1 provides the numbers of participants who enrolled for the two quantitative modules included in our study. At the time of writing this paper, data for the second semester of 2022 were not available yet, and are not included. It should also be noted that some students enrolled for both quantitative skills modules, as they are presented as sequential modules of the business programmes. As the data portrayed in Table 1 are linked to enrolments, and not individual students, those students are included in the demographic data for both modules.

Table 1: Module enrolments for two quantitative skills modules 2020-2022

Year	Quantway (1st semester)	Statway (2nd semester)
2020	497	528
2021	583	614
2022	727	Not available

The academic performance of participants in the first-semester module had steadily increased since 2020 in terms of the average final mark obtained (see Figure 3). Although the success rate of students passing the module remained the same, at 87%, in the year of Pathways implementation (i.e. 2021), it increased to 93% in 2022. The most evident change in academic performance of participants in the study is the proportion of students who passed the module with distinction (see Table 3). For the review period, the percentage of students who passed the first-semester module with distinction increased from 42% in 2020 to 60% in 2022. This may be indicative of a deeper understanding of the quantitative concepts by students after the implementation of the pedagogical changes accompanying the implementation of the Pathways programme from 2021 (see Figure 1).

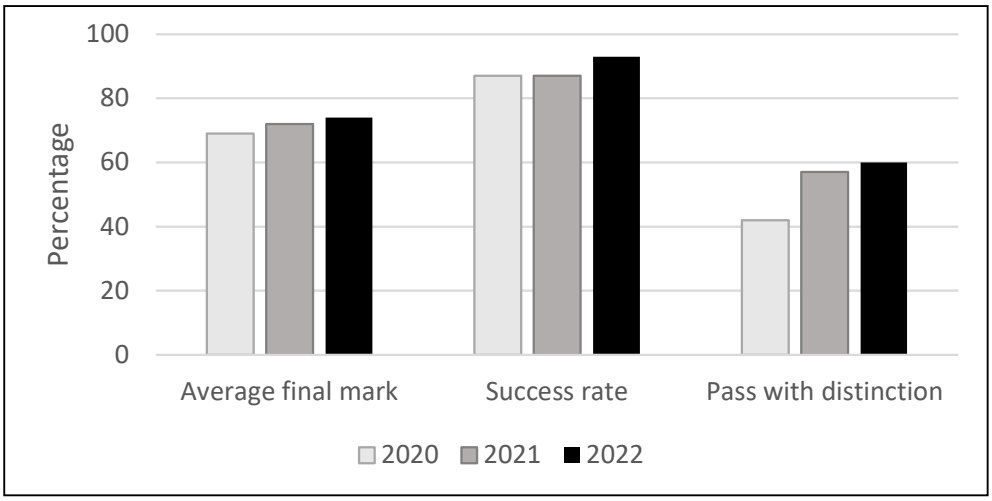

Figure 3: Overall academic performance in the first-semester quantitative skills module 2020-2022

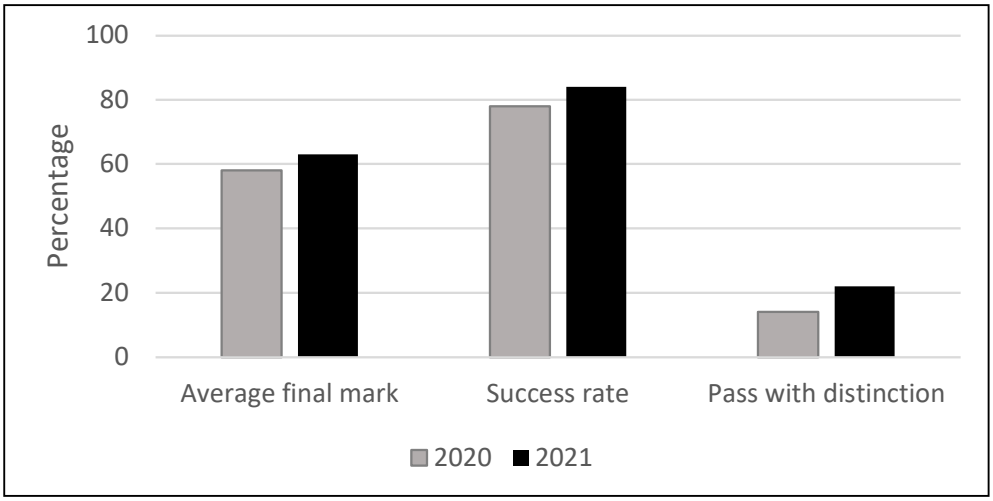

Figure 4: Overall academic performance in the second-semester quantitative skills module 2020-2022

Similar improvements in participants' academic performance were observed in the second-semester module. Figure 4 illustrates that all three data points showed improvement, with the average final mark, the success rate, and the proportion of participants with distinctions increasing by 5%, 6% and 8% respectively from 2020 to 2021. This improvement in academic performance is noteworthy given that, for most participants enrolled, this second-semester module would have been their first exposure to statistics/statistical concepts.

An analysis of variance on the three cohorts enrolled in EQMB1514/Quantway for the period 2020-2022 was conducted to determine whether a statistically significant difference in academic performance, measured through the final mark, was evident. The analysis of variance to compare the performance over three cohorts in the second-semester module (EQMB1524) is not included in this study, as the final marks for the 2022 cohort were not available at the time of writing. The Shapiro-Wilk normality test was applied and indicates that the distribution of the final mark for the three cohorts is skewed. Further, Levene's test indicated a violation of homogeneity ($p \leq 0.01$). Therefore, the non-parametric Kruskal-Wallis test was applied to compare the academic performance across the three cohorts. The results are presented in Table 2.

The Kruskal-Wallis test indicates statistically significant results for the cohorts ($p < 0.05$, 0.000000131). To understand the differences between group pairs, the Dunn's Test of Multiple Comparisons, which served as a post-hoc test to the Kruskal-Wallis, was applied.

Table 2: Results for the comparison of final marks across cohorts 2020-2022

Post-Hoc: Dunn Test						
Variable	***group1***	***group2***	***n1***	***n2***	***Test statistic***	***p-value***
Final mark	2020 cohort	2021 cohort	495	577	4.4450920	0.0000088
Final mark	2020 cohort	2022 cohort	495	727	5.3644361	0.0000001
Final mark	2021 cohort	2022 cohort	577	727	0.7223671	0.4700688

There are statistically significant differences in academic performance between the 2020 (pre-Pathways) cohort, the 2021 (Pathways) cohort ($p < 0.001$, 0.0000176) and the 2022 (Pathways continued) cohort ($p < 0.001$, 0.0000002). Interestingly, there is no statistically significant difference between the 2021 cohort and 2022 cohort ($p < 0.001$, 0.4700688) when comparing the academic performance of the two years where Pathways was offered.

When reviewing the positive findings regarding academic achievement reported in this study – achieved during the COVID-19 pandemic – behavioural engagement might provide some insights. Bond, Buntins et al. (2020) link achievement to other behavioural constructs, such as confidence and attention/focus. Confidence, especially within the context of quantitative skills (or mathematics) development, plays a crucial role and should be considered by this study. The three-step pedagogy employed in the Pathways programme is based on a clear set of drivers that focus on supporting students to develop skills and maintain positive mindsets, and to ensure that students see material as interesting and relevant, amongst other factors (McKay, 2016). Through these drivers, student confidence is built, which translates into students being willing to share their learning more openly with their peers and/or teachers (facilitators), in turn, building greater confidence and leading to a positive snowball effect. Through these learning collaborations, students remain attentive and focused, and link further to increased engagement, as alluded to by Bond, Buntins et al. (2020). Student comments support the increase in their confidence and its link with increased academic performance, as reported below.

> The biggest benefit from this module is the confidence that I gained from working in a group and being comfortable telling my thoughts and input to the group. Another benefit is that my general quantitative reasoning skills have developed more and improved. (Participant 47)

> I have gained confidence to work in groups when it comes to the math. It makes it easier learning some concepts because if you do not understand your group members can help. (Participant 49)

> The group work gave me confidence and when is [I] started engaging more and more in collaborations, my math improved and i can confidently say that my quantitative skills are

> on another level. I even apply them in everyday life, now I know why math is so useful. (Participant 112)

Based on the discussion above, the importance of including small-group collaborations in curriculum design for quantitative skills development (even in large classes, as in our study) is evident. However, within the South African context, with varying challenges regarding data and/or device availability, and as also alluded to by Baker et al. (2022), curriculum flexibility should be considered within this reality. In our study, from the second semester of 2021 (see Figure 1), students who faced challenges relating to data and/or devices, were provided with access to university resources – computer laboratories and the university Wi-Fi network. This enabled students to engage in small-group discussions, even if it was on campus and not from home. This type of flexibility in the curriculum delivery enabled more students to engage actively, and should be considered in post-COVID blended and/or online offerings. In addition to data and/or device challenges, technical difficulties, and even the technical knowledge and skills of students (as referred to by Bond, Bedenlier et al. 2020), should be considered in future blended and/or online offerings. Such difficulties could lead to frustration in students, and even disengagement from the learning process, as mentioned earlier. Some comments in this regard by students in our study are shared below. When students were asked to describe the challenges they experienced in the module, they responded as follows:

> Module 1 and 2 because I was[n]'t able to attend it because of technical changes. (Participant 107)

> Accessing the units frequently was a problem as sometimes I would be thrown out of the unit to start again. It was probably more of a technical issue than anything. (Participant 120)

With the implementation of the Pathways programme, students who were enrolled in the modules included in our study had access to technical support by both the Pathways and the university technical teams. This was especially important at the beginning of the module (see the comment above referring to modules 1 and 2) and should be an important consideration for future blended and/or online programmes. Even though the provision of technical support in a module might seem cumbersome, the data from our study indicate the importance of affording students the opportunity to participate in small-group discussions (or collaborations); there is a statistically significant correlation between the completion of (i.e. participation in) collaborations and the academic performance of participants in our study ($r = 0.41$, $p < .001$ in 2021 and $r = 0.60$, $p < .000$ in 2022). In the case of students who could not participate in a synchronous collaboration session, students were allowed to submit their groupwork (or collaboration) assignments individually to include another layer of flexibility in the curriculum design and delivery. This approach provided the pathway to an alternative asynchronous scenario, where self-regulated learning promoted the completion of the task by the participant. Such options could also be considered when moving beyond COVID-19 into a more human-centred blended and/or online environment.

With continuous changes to the national and university COVID-19 regulations during the study period, and the resulting changes in the two quantitative skills modules (see Figure 1), student and staff (facilitator) experiences were measured throughout by means of surveys, WhatsApp® voice notes, semi-structured interviews, and module evaluations. A survey on the student experience was administered to participants after they had completed the first-semester module, Quantway, in 2021 and 2022; response rates of 47% (n=273) and

31% (n=223) respectively were achieved. Table 3 provides an overview of some of the responses that were considered in the directives suggested for quantitative skills modules beyond COVID-19 (see Figure 5), and which are relevant to student engagement literature. Note that the responses generally exclude responses linked to aspects discussed earlier in the article, namely technical difficulties, availability of data and/or devices, confidence and attention/focus.

Table 3: Student experiences in the first semesters of 2021 and 2022

Which experiences in this module were valuable and would you like to see in other modules that require similar quantitative skills?
The groupwork was helpful and mind opening as it opens one up to different ways of solving problems and it enhances one's creativity. (Participant 91)
The collaborations and preparations, the preparations prepare you on what to expect in the collaboration, which makes the collaboration go smoothly. The collaborations push you to engage and participate, thus boosting one's confidence and furthermore improving one's quantitative skills. (Participant 111)
The module review questions, and memo was very helpful especially in preparation for tests. (Participant 139)
The 5-minute video summaries are quite reflective on the lessons and helps one think of the challenges they had in the lesson so that they can improve themselves. (Participant 158)
Using real-life situations everytime in an exercise. (Participant 175)
This module has units that are broken down into sections that build on to each other, the preparation builds your background knowledge, the collaborations were extremely helpful in terms of having us draw ideas from one another to getting more confidence to work alone in the exercises. This is very important and I think it should be implemented in other modules. (Participant 187)
Is to connect what we are learning with what happening in the real world. (Participant 272)
Describe the biggest benefits you have seen from using the learning approaches required for this module.
To make friends who will help through the academic, learning different study skills from them. (Participant 166)
I learned to break down work into different sections that work together, this is a very important skill in making it less overwhelming. Groupwork was good as I learned a great deal in terms of how to approach a question and skills in working with teams. (Participant 187)
The biggest benefit I have seen was the fact that my reasoning, explaining, people skills and even speaking English had improved a lot since I had to work in a group for this module. (Participant 207)
Firstly, the biggest benefit from group work is seeing each individual's approach or technique in solving a difficult question. This has helped me solve similar questions and understand difficult questions. Secondly, the learning approaches used in this module are extremely helpful as they allow a lot of practice before you can submit your answers to the questions provided. (Participant 241)
I got to understand a lot of things from a wide variety on how to approach certain questions. My marks improved a lot when I was doing the exercises and tests. (Participant 274)

Describe the biggest challenges you have had using the learning approaches required for this module.
I did not [have] any serious challenges the biggest was probably finishing the work on time. (Participant 138)
Not being able to share my screen as I use my phone to learn and that we lack tutorials on how to share. (Participant 161)
I think that the American context and setting was definitely the biggest challenge. I believe that if the content was more orientated on South African or African context (it) would have deminished [sic] the impact of the challenges. (Participant 206)
The biggest challenge I had was being a group leader because I was a shy individual. (Participant 227)
I had trouble adapting to the fact that I have to do a preparation before class and working in a group everyday. (Participant 271)
What was missing from this module that you would like to be included in future?
I would have liked consistency in the group members that we were allocated to work with. It makes doing the work harder when one constantly has to adjust to working with a new group of people every few lessons. I felt that it was unnecessary and frustrating at times. (Participant 47)
More South African concepts. (Participant 85)
More difficult or engaging work, I know it is an unpopular opinion but it is true if we as students do want to grow. (I hope if this is the case in the following semester, I am not held liable as that student who made it harder for others.) (Participant 152)
A session dedicated to the learners to get to know each other in their groups before continuing with work. (Participant 274)

The feedback provided in Table 3 reports that the importance of a human-centred approach to teaching and learning was repeatedly emphasised by students in our study. Feedback is mostly based on graduate attributes and/or skills learned, rather than the specific disciplinary content. However, the academic performance of participants in our study (see Figures 3 & 4) confirm that disciplinary content was understood well, and that deep learning might even have taken place.

Much of the learning and skills development that took place in the modules, as reported on in this article, could be attributed to teacher (facilitator) presence in the module. Continuous communication with the teacher (facilitator) was identified as valuable by some of the study participants (see quotes below).

> Having a good communication with my facilitator and also working hand in hand with different kind of people.it was quite a good experience. (Participant 184)

> Having collaboration with my facilitator and being able to ask questions. (Participant 213)

However, several participants in the study also alluded to the absence of a teacher (facilitator) to explain the content to them, indicating their "connectedness" with more traditional, transactional ways of teaching. When considering moving beyond COVID-19, and as included in the directives going forward (see Figure 5), explaining the pedagogy to students is an important aspect related to the study findings reported here. Some comments by participants in this regard are the following:

> More help from the facilitator during collaborations, I think more facilitators should be added because the facilitator only enters the collaboration and for only 2 minutes at most 5 minutes. (Participant 112)

> Maybe the facilitator can give us class and explain the work, rather than when we must do groupwork. (Participant 124)

This section of the article focused on the results obtained for students enrolled in two quantitative skills modules from 2020 to 2022 at a South African university. From these results, important directives are proposed for quantitative skills development modules when moving beyond COVID-19 to a sustainable, futuristic teaching and learning environment that integrate the best practices from pre-COVID-19 and COVID-19 experiences.

6. Limitations and recommendations for further research

Proximity and researcher bias as possible limitations of this study are addressed earlier in the Methodology section. Generalisability of results could be a further limitation of this study, as it was only researched at one institution and in particular modules and contexts. However, the findings could provide valuable insights into the utilisation of a flexible curriculum structure, especially within a large context. Future research could focus on implementing similar teaching and learning approaches in different modules and different contexts to enhance generalisability of findings. Other focus areas for further research could include the social emotional learning facets within student-staff relationships, student experiences and engagement, especially within a technology-enhanced environment.

7. Conclusion

Moving beyond COVID-19 is an exciting, but challenging time for the higher education sector. Two key themes emerged from the literature published on COVID-19 teaching and learning experiences, and were confirmed by our study, namely the importance of flexibility within curriculum design and delivery, and a human-centred focus of the teaching and learning space (including student and staff experiences/engagement as well as student-staff relationships). In moving towards a high-quality, human-centred post-COVID-19 space, the importance of integrating strategies directly linked to these key themes cannot be ignored. Figure 5 provides directives to create a flexible, human-centred quantitative skills development environment, based on the results of our study. Interestingly, in 2014 (pre-COVID-19), Barnett, through the Higher Education Academy, had already alluded to a set of conditions for flexibility to secure a more responsive higher education system. The conditions proposed by Barnett (2014) that are linked to the directives suggested in this article are: 1) Offering students access to suitable materials and experiences; 2) Offering academic interaction with other students; 3) Offering access to tutors in real-time interaction (i.e. small-group collaboration in the context of our study); 4) Enabling students to provide feedback on their total (learning) experience; 5) Providing a pedagogical openness; 6) Exhibiting academic and educational structure; and 7) Offering sufficient challenge to “stretch” students, yet being critically appropriate for each stage of learning.

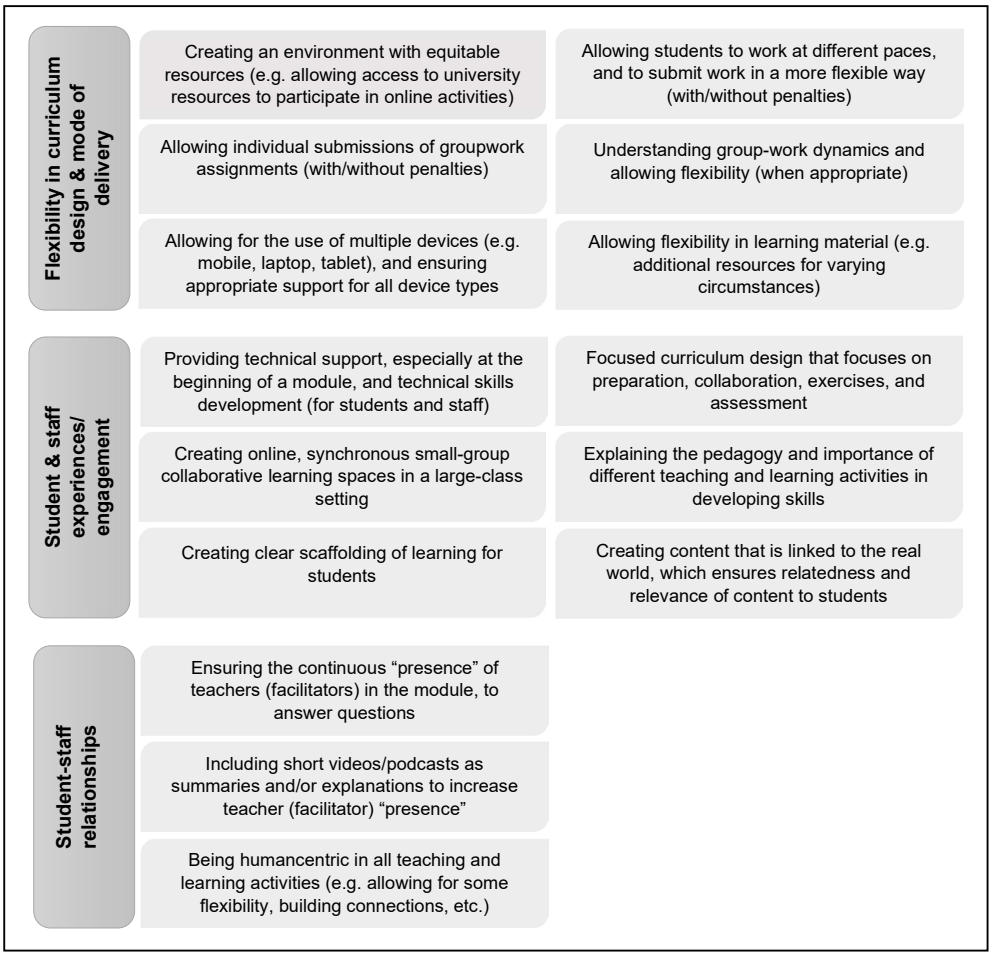

Figure 5: Directives for creating a flexible, human-centred quantitative skills development environment

The positive results obtained during the COVID-19 pandemic led to important curriculum decisions for a normalised future in these modules, which are built on flexibility and a human-centred view (and linked to the directives provided in Figure 5). These decisions included, for example, the continuation of the modules in an online environment, even when students returned to campus. The main reason for this decision was to create an opportunity for students to engage in small groups, even within a large-class setting (see Table 1 for enrolment numbers), whilst having access to university resources to facilitate online learning. Such intentional flexibility could, thus, provide a basis for a more human-centred approach to teaching and learning in a normalised post-COVID-19 educational space.

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