RESEARCH ARTICLE:

"Are we Producing Teachers for the 4IR Digitized Classroom?" – A Case Study of a School of Education

Orhe Arek-Bawa[1] and Sarasvathie Reddy[2]

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Abstract

With over two years of remote online learning, this paper assessed the extent to which academics in a School of Education (SoE) at a South African university employed their espoused (Technological, Pedagogical, and Content Knowledge) TPACK in preparing teachers for the Fourth Industrial Revolution (4IR) classroom. Besides facilitating the development of disciplinary expertise, academics were expected to engage students with technological and other cross-functional skills needed to succeed as global citizens in a digitized society. Premised on the TPACK framework, a mixed-method approach using data from questionnaires distributed to all the academics in the SoE and interviews with five academics from the different disciplinary clusters of the SoE were analysed to explore their self-assessed TPACK to understand how academics prepare future teachers for the digitized 4IR classrooms. The findings suggest that academics may possess the relevant TPACK, but online educational practices may not have sufficiently equipped future teachers with the competence to thrive in the 4IR classroom. The outcome of this research provides valuable insights into academics' TPACK, especially those in teacher education, regarding their online pedagogical pursuit, the SoE in their quest to produce teachers fit for the 4IR classroom, and the scholarship of digital transformation in general.

Keywords: *digital transformation; 4IR classroom; cross-functional skills; teacher education*

Introduction

COVID-19 compelled the adoption of digital technologies affiliated with the 4IR as many traditional Higher Education Institutions (HEIs) transited to virtual modes of education worldwide (Gamage *et al*., 2020). Academics also known as lecturers or faculties were therefore mandated to move to emergency remote pedagogies via online platforms to meet the educational objectives (Alakrash and Razak, 2020; Oparinde and Govender 2020; and Khoza and Mpungose, 2020). It is envisaged that tomorrow's workforce will be produced by achieving such online educational objectives. Besides disciplinary expertise, these graduates should possess digital competence and other cross-functional skills to be employable (World Economic Forum 2020a; 2020b; PWC, 2019).

In response to online remote learning, the institution organized training workshops via zoom and other online platforms to upskill academics on the use of different e-learning tools and to acquaint them with how to interact with the Learning Management System for teaching, learning, and assessments (Amin *et al*., 2021). Academics, including those in the SoE, were expected to employ digital and technological skills in disseminating disciplinary knowledge to students via online platforms (Khoza and Mpungose, 2020). Research has shown that there is a digital divide between digital immigrants (academics) and digital natives (students) in their interaction with online technologies, with the latter being more enthusiastic and efficient (Khalil *et al*., 2020). Digital natives are those born after 1980 into a world surrounded by digital technologies while the digital immigrants were born previously. (Chen *et al*., 2010). Meanwhile, it is the academic's responsibility to organise teaching and learning systematically to attain the educational objectives on any platform (du Preez and le Grange, 2021; Khalil *et al*., 2020; Waghid and Waghid, 2016). For them to do so effectively, teacher educators should also possess the requisite TPACK (Lestari

[1]University of KwaZulu-Natal, arekbawao@ukzn.ac.za | https://orcid.org/0000-0002-1485-132
[2]University of KwaZulu-Natal, reddys15@ukzn.ac.za | https://orcid.org/0000-0001-9344-7431

and Santoso, 2019; Bingimlas, 2018). Despite the mandatory move to online pedagogies for just over two years now, it is not clear the extent to which academics in the SoE possess the requisite TPACK and are developing future teachers to be fit for purpose for the digitized 4IR classrooms that awaits them. This study aimed to explore academics' espoused TPACK competence in preparing future teachers for the digitized 4IR classrooms. Premised on the TPACK framework, this paper employs a mixed-method approach to answer the following questions:

i. What are academics' espoused competencies in TPACK in preparing future teachers for the 4IR classroom?
ii. How do academics engage TPACK in preparing future teachers for the 4IR classroom?
iii. To what extent have academics prepared future teachers to teach in the 4IR classroom?

This paper promises useful insights to academics who seek quality learning in their digital pedagogical engagement; to teacher training institutions in their quest to produce teachers fit for the digital age; and to the scholarship of digital transformation in the light of the 4IR. The following section proceeds with a review of relevant literature, including an explanation of the theories underpinning the research, followed by the research methodology.

Literature Review

Teacher education is vested with the onerous task of producing teachers for the school system from which a country's human capital is capacitated with skills and knowledge to contribute productively to the digitized 4IR workspace. The 4IR environment requires teacher education to move from an instructional paradigm that promotes memorisation and passive forms of learning where the teacher is a sage to a more pragmatic competency-based learning paradigm (Atibuni *et al*., 2022). Allied to the 4IR, this paradigm requires teachers with requisite TPACK as well as "skills and competencies in creativity, innovation, ingenuity, and higher order and critical thinking to solve complex and abstract problems as well as get along with one another and be civically engaged" (Atibuni *et al*., 2022). Unfortunately, the WEF (2020a) notes that many countries are still heavily dependent on the outdated instructional, educational systems that limit access to the skillset required to drive economies successfully. In other words, these students are unlikely to develop adequate competencies relevant to the socioeconomic advancement of the 4IR, thereby displaying functional illiteracy in the world of work (Atibuni *et al*., 2022). It is thus essential to understand how academics in the SoE equipped students with the relevant skills and competencies to thrive in their 4IR classrooms after graduation.

In any learning environment, educators are expected to adopt Good Teaching Principles (GTP) proposed by Chickering and Gamson in 1987 for learning to be effective. With the lockdown, Saiyad *et al*. (2020) further extended the principles to derive Good Online Teaching Practices (GOTP), which are highly applicable in a competency-based learning environment. Amongst other things, GOTP allows for both synchronous and asynchronous teaching engagements, constructive alignment of educational activities with the learning objectives, promotion of higher-order thinking and communication skills, summative and formative assessments, cooperation among students and active learning (Saiyad *et al*., 2020). For academics to apply these principles in online platforms, they must be competent. Besides traditional disciplinary and pedagogical knowledge, they must acquire digital technological competence (Li *et al*., 2022; Irwanto *et al*., 2022; Tanrisevdi, 2021; Saiyad *et al*., 2020). While academics may have navigated online platforms to conduct their educational activities in the past two years, the extent to which they have been capacitated with the requisite TPACK to enable effective teaching remains largely uncertain in the SoE. Hence this paper aims to contribute knowledge in that regard.

In addition to other programmes, the SoE offers the Bachelor of Education programme to students to provide them with knowledge and skills to teach in the South African basic school system in five disciplinary clusters. Each cluster offers discipline-specific content and teaching method courses across the four levels of study in the undergraduate programme. Students are expected to acquire traditional disciplinary knowledge from the content modules to teach the subject in schools. The teaching method modules aim to equip students with teaching skills as they employ diverse theories and approaches to content knowledge in their respective fields. By engaging with the content, teaching method, and other professional development modules, students are acquainted with the teacher education programme, which Kroon and Gravette categorised as "content knowledge; general pedagogical knowledge; curriculum knowledge; pedagogical content knowledge; knowledge of learners and their characteristics; and knowledge of educational contexts" (2023: 4).

In the fast-changing world of the 4IR, Kroon and Gravette emphasize the need for academics to engage teachers with tasks that require "complex thinking, metacognition, and problem-solving; are engaging; and allow for social interaction, experimentation, and curious exploration" to enable deep learning (2023: 12). Subsequently, student teachers develop these skills/competencies which they can in turn transfer to their learners. The extent to which the pedagogical practices of academics in the SoE enabled deeper learning, and the acquisition of cross-functional skills amongst students in the SoE remains uncertain. This paper foregrounds the academics' experiences and espousal of how their pedagogical practices prepare future teachers for the 4IR.

In addition to disciplinary expertise and digital technological skills, tomorrow's workforce should be equipped with other cross-functional skills, of which the ability to think critically, analyse and solve problems, create, and innovate, together with interpersonal skills are commonly recognized (WEF 2020a; 2020b; PWC 2019). These cross-functional skills are usually allied with higher cognitive attributes and soft skills that are not easily automated in this digital era (Teo *et al*., 2021; Virtanen and Tynjälä, 2018). Scholars (Teo *et al*., 2021; Mustakim *et al*., 2021; Menon and Castrillón, 2019; Virtanen and Tynjälä, 2018; Stanley and Marsden, 2012) have considered cross-functional skills for years. Common approaches recommended for developing cross-functional skills are mostly learner-centred and stem from active pedagogical engagement, as suggested in the Education 4.0 report (Mustakim *et al*., 2021; WEF, 2020a). They include problem-based learning, questioning, collaborative and interactive learning, case studies, self-reflective journals, and blended learning. In this research, the pedagogical practices of academics in the SoE derived from questionnaires and interviews were examined to determine the extent to which they enabled the development of students' cross-functional skills in preparation for the 4IR classroom.

The 4IR classroom is the workplace for teachers where the technology of the 4IR drives the education system. The incorporation of technology is evident in "the use of knowledge transfers such as platforms, learning materials, classroom settings, learning space, knowledge presentation and more" (Alakrash and Razak, 2020: 7). Teachers exploit the affordance of digital technologies to direct and aid learning in the classroom (Kroon and Gravett, 2023). They are seen as facilitators or mediators of learning rather than instructors (WEF 2020a). The utilization of the internet and the incorporation of technology can be done through e-learning, MOOCs, or blended learning in this interactive and engaging classroom (Alakrash and Razak, 2020). Such interactive methods promote critical and individual thinking required in the current innovation-driven world (WEF, 2020a). Academics and future teachers tasked with training the workforce of the 4IR must themselves be "trained in the digital technologies domain" so that they can "improve educational approaches inside the classroom" and overcome possible challenges (Alakrash and Razak, 2020: 10). Thus, the teacher in the 4IR classroom aims to facilitate meaningful knowledge construction amongst learners to meet the needs of the fast-changing society (Atibuni *et al*., 2022). The extent to which the SoE is producing future teachers for this 4IR classroom is yet to be researched which this study aims to contribute knowledge.

Theoretical Framework

The TPACK model proposed by Koehler and Mishra (2009) serves as a suitable framework for understanding academics' espoused TPACK competence in preparing future teachers for the digitized 4IR classrooms. TPACK can be described as the knowledge required to teach effectively with technology (Bingimlas, 2018). Rather than treating each of these three overlapping components (Technological Knowledge [TK], Pedagogical Knowledge [PK], and Content Knowledge [CK]) as an independent entity, they should all be viewed as interdependent aspects of a bigger, more complicated knowledge structure (Koehler and Mishra, 2009). The intersection of the individual domains (Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK)) depicts the academic's ability to transcend knowledge structures. However, meaningful teaching with technology is exhibited at the point of TPACK, described as "an understanding that emerges from interactions among content, pedagogy, and technology knowledge" (Koehler and Mishra, 2009: 66).

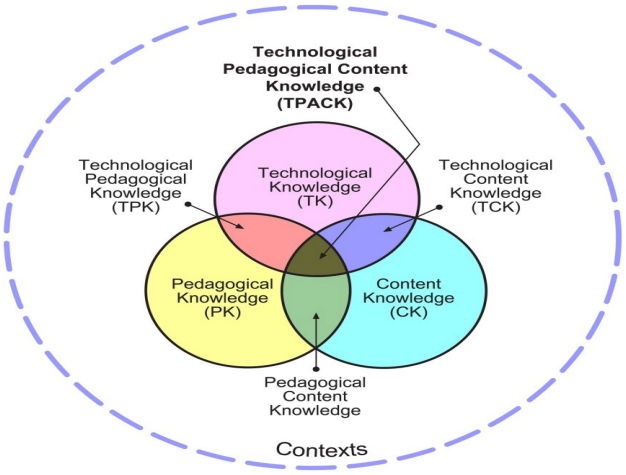

Figure 1: The TPACK framework (Koehler and Mishra 2009: 63)

Although scholars (Koehler and Mishra, 2009; Bingimlas, 2018) assert that the adoption of technologies in the pedagogical process in any discipline is a function of the contexts of learning, the context was not explicitly articulated. In addition, the TPACK model is generally flawed for its complexity and lack of clarity in construct distinction theoretically (Graham, 2011). Nonetheless, this model is considered useful in understanding teaching in a technological environment and in determining the knowledge that academics should possess to facilitate learning with technology effectively in diverse fields (Martin, 2015; Schmidt *et al*., 2009). Further, in the 4IR learning environment, TPACK appears to be "a required area of expertise for teachers" (Joo *et al*., 2018: 48). It is therefore imperative to assess the TPACK competence of academics in the SoE.

Methodology

A mixed-method approach focusing on the SOE as a case study was adopted in this research. The case study design helps explain "'*how,' 'what,'* or '*why'* questions" (Crowe *et al*., 2011:4) which is the focus of this research. A mixed-method approach will not only enhance the validity of our research via triangulation but will also "expand and strengthen a study's conclusions and, therefore, contribute to the published literature" (Schoonenboom and Johnson, 2017:111). The research is further located within the pragmatic paradigm since it aims to provide a comprehensive understanding of academics' experiences of developing teachers for the digital age (Kivunja and Kuyini, 2017). Where the primary objective is exploratory, Morse and Niehaus (2009) cited in Schoonenboom and Johnson contend the theoretical drive is inductive and as such, the "core" component is qualitative denoted by QUAL + quan (2017: 112). The first four letters of core component (in this case, qualitative) are written in upper case while those of the supplementary component (quantitative) in lower case. Even though the quantitative and qualitative findings of the study can arguably stand on their own, this study aligns more with the QUAL + quan design as the study aimed to explore the extent to which future teachers are prepared for the digitized 4IR classrooms (Hafsa, 2019; Schoonenboom and Johnson, 2017) employing a convergent parallel strategy.

Mixed-method research can generate quantitative and qualitative data (Schoonenboom and Johnson, 2017). In this research, data was generated quantitatively via questionnaires distributed to all academics in the SoE and qualitatively from interviews with five academics across the undergraduate clusters of the SoE. The qualitative interviews served two purposes – triangulation as some questions elicited responses to corroborate data generated from the survey and complementarity as it addressed other aspects of the research to elaborate and enhance the results (Hafsa, 2019; Schoonenboom and Johnson, 2017). The questionnaires were designed on Google form, which also helped to collate the responses. The initial plan to distribute the survey to all academics in the SoE via the university notice system yielded zero responses, necessitating an amendment to contact available academics physically. Of 60 academics who permitted the links to be emailed to them, 31 responded after repeated contact. During the same period, we purposively sampled five academics from the five clusters of the SoE offering undergraduate programmes for in-depth qualitative interviews. This falls within the threshold (five to fifty) deemed adequate to achieve trustworthiness in qualitative research (*Vanover et al*., 2022). Interviews held physically and via zoom were audio recorded, transcribed, and emailed to participants as member checking to enhance the credibility of the data. See table 2 below:

Table 2: Summary of data generation

	Survey	Interview
Country	South Africa	South Africa
Date of Survey	August to November 2022	November to December 2023
Audience	Academics in undergraduate programme – - Population - About 80 - Consenting Academics- 60	Academics in undergraduate programme – 1 per cluster = 5 Interviewed
Response rate	30	5

Data Presentation and Discussions

The survey instruments predominantly comprised closed-end questions that were broken down into two sections—A, sought to gather demographic data such as gender, age, and teaching experience from participants. Section B was broken into three parts – the first focused on participants' internet access, their perspective of the digital infrastructure, and transformation drive in the SoE. The second part of section B was structured using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5), focused on the seven domains of the TPACK framework. A total of 48 items covered the different domains of TK(9), PK(8), CK(6), TPK(8), PCK(5), TCK(7), TPACK(5). Drawing from the work of Bingimlas, (2018), the question items were adapted based on literature from the work of Kamsker, Janschitz and Monitzer (2020) as well as that of Schmidt *et al*. (2009). This is considered adequate because the TPACK instrument has been validated for years via exploratory and confirmatory studies (Bingimlas, 2018). The third part enquired about academics' success experiences, difficulties, and ways of improving their online pedagogical practices. Out of 31 responses received, one was invalid, leaving thirty responses. The result of the survey on academics' self-espoused TPACK is presented in seven domains.

Technological Knowledge (TK): Going by the extent to which academics agree and strongly agree with the statements provided in table 2, the bar graph in figure 1 indicated that they were generally satisfied with their levels of TK. Over 60% agreed.

Table 2: Details of Academics' Espoused Technological Knowledge

Technological Knowledge (TK)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Use popular application software	0	1	1	12	16	30
Use social media (Twitter, Facebook)	1	2	2	10	15	30
Host meetings on online conferencing platforms	0	0	0	11	19	30
Use the basic devices	0	0	1	12	17	30
Install software programs	2	5	6	10	7	30
Solve fundamental technical problems	4	11	6	7	2	30
Can create and edit videos and podcasts.	4	9	8	7	2	30
Can host forums access cloud service.	1	8	8	5	8	30
Can create my personal website.	9	14	3	3	1	30
Total	21	50	35	77	87	270

From the details provided in table 2, participants were quite confident in their use of conferencing facilities (zoom, Microsoft teams, Google meet), use of basic devices (printers, scanners, projectors, digital cameras, etc.), use of popular application software (Word processor, presentation graphics, spreadsheet), use of social media and host discussion forums. The rather high level of confidence in the area can be attributed to repeated engagement with online technologies for more than two years, catalysed by the COVID pandemic (Arek-Bawa and Reddy, 2020). Conversely, participants appeared less confident in their ability to create videos, website and address basic technical challenges. This is understandable because academics can transmit basic pedagogical activities online without using/interacting with these media.

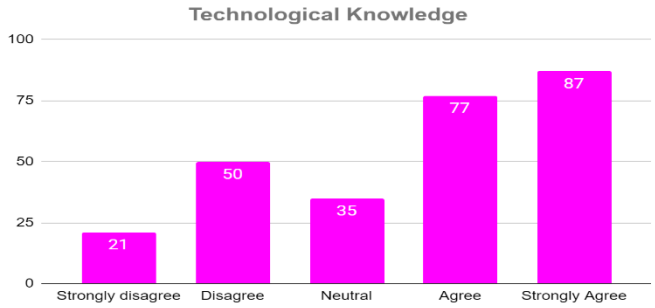

Figure 2: Academics espoused technological knowledge

Concerning PK and CK, academics were highly confident, as seen in figures 2 and 3 below. In addressing PK, participants assessed their knowledge of teaching methods and practices, such as classroom management, connecting various concepts, and assessing students in diverse ways. Regarding CK, they considered their subject-matter competence via their ability to teach subject matter confidently, assist colleagues with the subject, source relevant content, etc. In TK, they judged their ability to use information technology effectively.

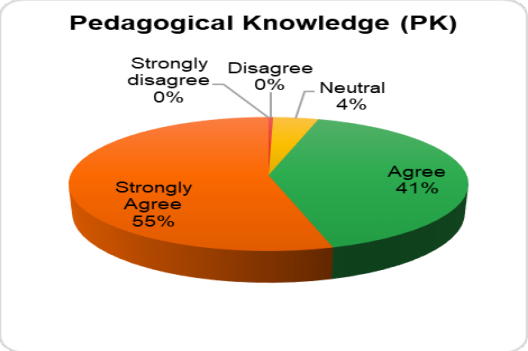

Figure 3: Academics espoused PK

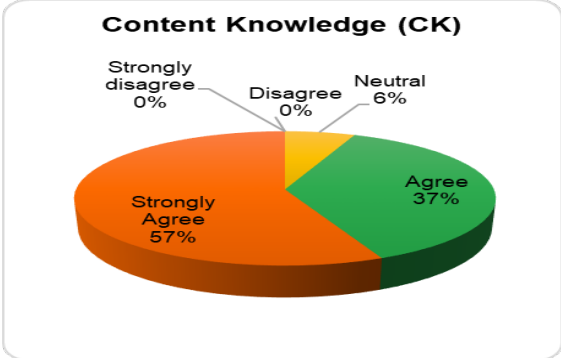

Figure 4: Academics espoused CK

These high confidence levels in PK and CK are not unusual because they have engaged with these knowledge domains from the start of their academic career. This outcome affirms the work of previous scholars (Li *et al*., 2022; Irwanto *et al*., 2022; Bingimlas, 2018; Schmidt *et al*., 2009) who concluded that participants were more confident in their PK and CK than in TK.

In assessing TPK (see figure 4), they considered their ability to use appropriate technologies to motivate student learning, develop teaching approaches, engage students, evaluate students, and manage smart classrooms. The survey recorded a high confidence level (76%) even though they felt less capable of teaching with social media and managing smart classrooms. A similar outcome was obtained in their assessment of TCK (78% confidence level), where they scrutinized their ability to use new technologies to assess, develop new knowledge, and represent content as shown in figure 5. Similarly, using new technologies (multimedia, simulation, animation, and modelling) remained challenging for some academics.

For all the participants, PCK received an overwhelming 100% confidence rating in their ability to develop appropriate assessments, use appropriate teaching strategies, prepare effective learning activities, etc. (see figure 6). This is unsurprising as many would have acquired this knowledge from teacher education training and daily classroom experience. The lower levels of TCK and TPK compared to PCK can be attributed to the impact of TK, with which academics were not as familiar. Further, with the increasing technological advancement as the 4IR unfolds, the need for continued training becomes imminent to keep up with TK (Ilomäki *et al*., 2016). This partly aligns with Li *et al*., (2022) work, which concluded that teachers' TK was low.

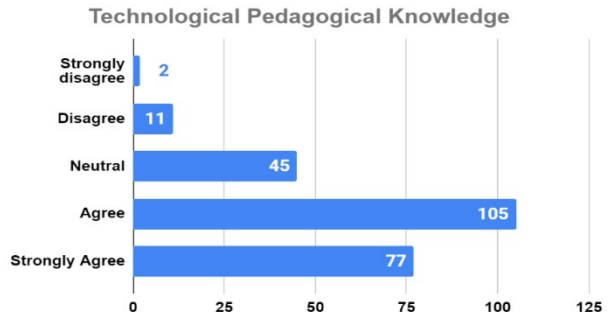

Figure 5: Academics espoused Technological Pedagogical Knowledge

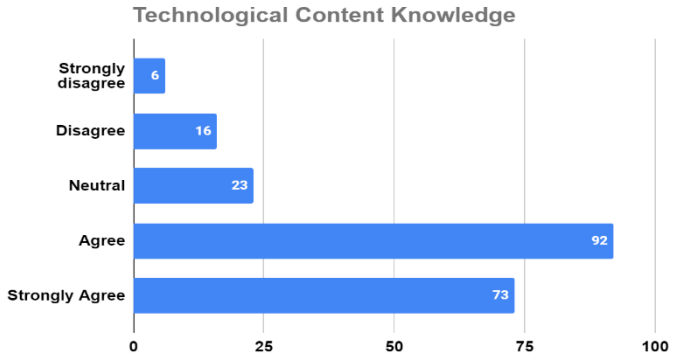

Figure 6: Academics espoused Technological Content Knowledge

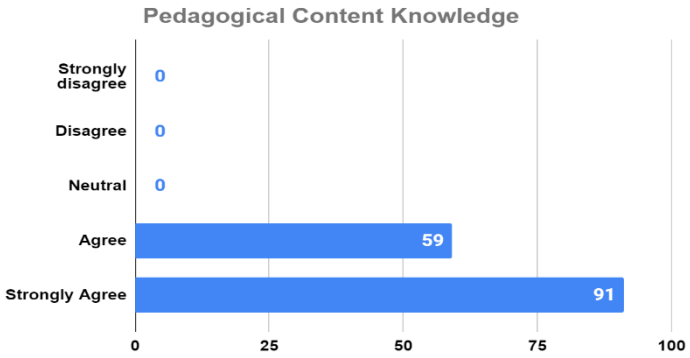

Figure 7: Academics espoused Pedagogical Content Knowledge

In general, academics in the SoE were confident in engaging technology to engender meaningful learning in their respective fields. In other words, they considered themselves expert teachers who could integrate modern technology in effectively teaching their subjects (see figure 7). Many believed they could navigate learning management systems, use new technologies and social media to facilitate constructive learning, and assist others in their specialty. As seen in figure 7, about 73% of participants are confident in their TPACK.

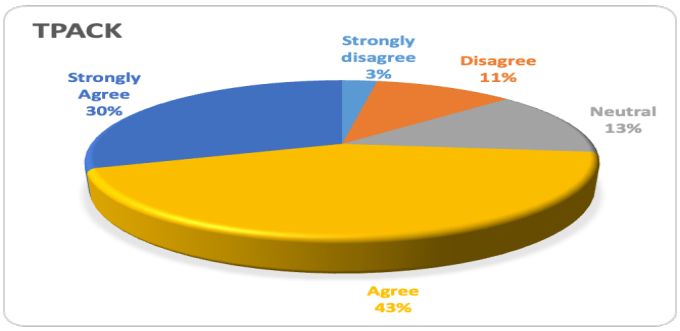

Figure 8: Academics espoused Technological Pedagogical Content Knowledge (TPACK)

On the one hand, the outcome of this survey confirms the work of previous scholars (Li *et al*., 2022; Irwanto *et al*., 2022; Tanrisevdi, 2021; Erdogan and Sahin, 2010). Li *et al*. (2022) investigated teachers in China and concluded that their TPACK abilities were generally high. Irwanto *et al*. (2022) also reached the same conclusion from their assessment of preservice teachers' perception of their TPACK abilities in Indonesia. Tanrisevdi (2021) further concurred based on a survey of Science teachers' TPACK competence in Turkey. On the other hand, Mporananayo and Ng'umbi (2019) investigated TVET tutors' TPACK in Rwanda and concluded that it was at a low level. Bingimlas' (2018) study on teachers' self-assessed TPACK in Saudi Arabia recorded average confidence levels. Erdogan and Sahin (2010) further concluded that student teachers in the secondary school programme in Turkey were less competent in their TPACK domains than those in the primary school programme because the former were less exposed to TPACK. A chronological analysis of the above studies indicates an increasing trend towards higher levels of TPACK, possibly attributed to higher exposure to and use of digital technologies in their pedagogical engagement catalysed by the pandemic, similar to the case of the academics in the SoE.

The research also examined how academics engaged TPACK in preparing future teachers for their 4IR classrooms, facilitating the acquisition of cross-functional skills (Mustakim *et al*., 2021; WEF, 2020a). Figure 8 shows that academics in the SoE used a blend of active and passive approaches in their pedagogical pursuit. On the one hand, the graph shows the least used teaching approaches were those with the tendency to promote active engagements such as games, role play, reflective journals, and case study. Of the four strategies, implementing role play in a synchronous classroom may be difficult since students log in from different locations. The others lend themselves easily to virtual platforms with possibilities to interact with real-world issues in various disciplines.

The graph also indicates that academics often used presentations, synchronous zoom classes, whole-class discussions, and recorded lectures. Even though teaching presentations were part of the learning activities in teacher education in the pre-pandemic era, they became crucial due to social distancing as academics sought to authenticate their students' work. These presentations are usually open for discussions and feedback from peers and the academic, providing a rich platform for learning and active engagement if executed well.

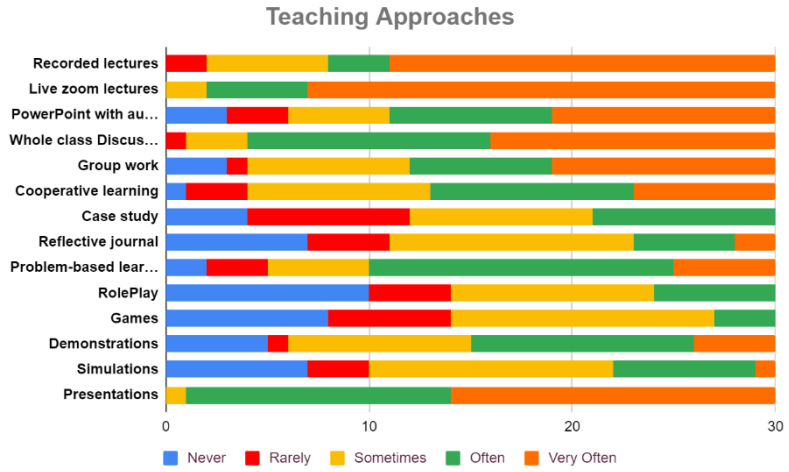

Figure 9: Teaching approaches adopted by academics

In synchronous zoom classes, the possibility for active engagement is high depending on the other strategies used in the classroom. Whole class discussions and group work offer similar opportunities for active engagements. However, recorded lectures and PowerPoint presentations with audio are virtually the same modes of passive instruction transmission with little avenue for students to contribute, question, or clarify learning. From the above, academics in the SoE employed both passive and active strategies in preparing future teachers for their 4IR classrooms. The next question is why and how did academics utilize these strategies in their online pedagogical engagements? Excerpts from the interview with academics answer this question while offering a broader understanding of their pedagogical practices. In line with the mixed-method convergent parallel design, certain responses from the qualitative interviews corroborated the survey findings while others addressed the third research question pertaining to the extent to which academics felt that they prepared future teachers to teach in the 4IR classroom.

Qualitative Findings and Discussion

All five academics interviewed stated that they implemented a blend of strategies progressing towards more active approaches as they became more familiar with teaching online. Academic A explained topics guided by PowerPoint presentations, after which he initiated class discussions/question and answer sessions. For him, "*discussion is the most [helpful]" as* he aimed for *"student engagement in terms of participation".* Academic B struggled to engage his students at the start of online learning, which constrained him to more teacher-centred approaches. After he "*…. attended one of those seminars and workshops, … I managed to develop some skills on how to actually engage students*" by "*putting our students into breakout room" so that, "they can have a discussion*". In the case of Academic C, she resorted to PowerPoint with audio when she heard about other students' unhappy experience of synchronous zoom classes due to connection problems. Although she realised that the students "*were not able to ask any questions*," she gave "*them an instruction at the end of my recording … to write me an email*" stating precise areas of clarification. For Academic D, "*Online teaching is more … learner-centred*." He mainly used discussions forums *"at the end of each topic".*

Academic E had "*a fair amount, unfortunately, of transmission*". To engage students in her synchronous large class meetings, she hired an assistant who kept a register of those who participated. The register was shared on the learning site at the end of the week, "*so everybody sees who participated and who attended*" so "*that you don't sit in front of your computer blank and do something else*". She believed, "*It worked very well, but unfortunately, it did cost me because I had to pay the student*". She further used their feedback in the lesson to facilitate "*a co-construction of knowledge".*

A common thread from the interview is that participants understood the importance of engaging students in their learning journey. The limitations posed by the computer screens, internet connectivity, and electricity in their synchronous engagements did not deter academics from devising strategies to bring students into the learning space. Although most of them commenced with passive teaching approaches using PowerPoint slides/(audio), and transmission similar to Damşa *et al*. (2021) observations, they later strived to engage students by eliciting their contribution by name and through discussions as a class, in virtual forums, or in breakout rooms. In a way, the outcome of the interviews confirms the responses from the surveys but goes further to reveal the efforts made by academics to engender students' participation. Thus, it can be inferred that the teaching approaches adopted by academics in their online pedagogical engagement could have contributed to equipping students with requisite skills for future classrooms, though in a limited way mirroring conclusion reached by others in Norway (Damşa *et al*., 2021).

It can also be argued that academics played it safe in a platform susceptible to more advanced virtual teaching strategies (Damşa *et al*., 2021:13) that engenders students' interactivity and engagement. Still, it is essential to recall the pre-pandemic setting. For many, the pandemic plunged them into uncharted waters where they had to re-learn new ways of disseminating instructions/facilitating learning (Amin *et al*., 2020; Damşa *et al*., 2021). Although the institution capacitated the academic community through training workshops, they were generic (for Academic C as they were not easily applicable in the second language classroom). Like Academic B, subsequent training afforded many of them the skills to facilitate small group discussions via breakout rooms. Thus, continuous training is needed to expose academics to more active online approaches amid rapidly evolving digital technologies (Ilomäki *et al*., 2016) to further the skills required for the 4IR workspace.

Despite the efforts to engage their students, academics had mixed perceptions of their competence regarding the knowledge and skills they could have acquired in the virtual learning journey. Academic A did not believe that students developed the requisite skills to be competent teachers because of the "*high rate of absentees where they do not come at all*" and the possible "*manipulation*" of assessments where students "*sit in groups [and] write at the same time*" in an individual assessment. Academic B shared the same sentiments in mathematics education, stating, "*I'm not confident with the kind of teachers we are producing currently*". He gave an instance where "*Students said "we are doing better when it's online, but when it comes to face-to-face, then we fail dismally".* Academic C also concurred for other reasons. The curriculum content in the online module templates used to guide online learning "*had to [be] cut down …to suit the online teaching environment. And in cutting those things down, we were unable to put in the most important component, like the classroom presentations, the group presentations*". In addition, she added that the nature of the assessments was changed to "*multiple choice questions because the essay type was also problematic during the online teaching*". She also alluded to issues of

academic dishonesty. According to her, "*I don't even know if the student logged in for herself or himself to write".* Even though Academic D was quite *"confident that they have acquired the content, …they can manage their classrooms; they can manage their learners very well".* However, "*... I may not say much of the kind of technology that they will meet there if they will be able to manoeuvre such technology*".

On the one hand, Academic E was happy with the calibre of students she produced because she took extra measures to attract them to class, engage them and ensure the credibility of her assessments. On the other hand, she was aware of the difficulties other lecturers reporting to her had in relation to assessments. She bemoaned an online education system that allowed students "*who has never showed up the entire semester, who decides to show up in the last two weeks and who insists that all the tasks must be opened"*. In her view, those *"students would have learned nothing. If I open tasks that have been reviewed, that student is just going to copy; would know the answers from the friends; I don't even know if that student is taking the test*".

From the above, the extent to which they facilitated effective learning is debatable. Besides issues related to electricity/internet connectivity attested to by all participants**,** unchecked absenteeism/limited engagement, inability to ensure the credibility of assessments due to dishonesty, contract cheating and proctoring concerns, reduced content, and leniency on the part of management hindered learning. Drawing from the GOTP (Saiyad *et al*., 2020) principles, while academics may have conducted their lessons synchronously and asynchronously, issues of reduced content meant that learning outcomes might not be attained. Unchecked absenteeism/limited engagement implies minimal student-teacher interaction and engagement with learning materials. The assessment issues alluded to by academics questions the integrity of online assessment systems, summative tasks, the "*credibility of the course and the degree eventually*" (Academic E). As such, it is unlikely that effective teaching/learning affiliated with the competency-based environment of the 4IR has ensued; hence academics are not confident in their students' ability to thrive in the classroom.

Some of the findings are similar to those of previous scholars (Mishra *et al*., 2020; Gamage *et al*., 2020). According to Gamage *et al*., 2020) in their review of the integrity of online assessments, the issues discussed above are more pronounced in low-income contexts such as the SoE. Most of the institution's students are from the lower quintiles of the South African school, characterised by poverty and low income (Le Grange *et al*., 2020; Dass and Rinquest, 2017). Literature reveals that online learning exacerbated the inequalities in the South African schooling system, creating a digital divide along socioeconomic grounds (Dison *et al*., 2022; Arek-Bawa and Reddy, 2022; Jansen, 2021). For those at the bottom end of the digital divide, low levels of digital literacy, inability to access learning resources when required together with the reluctance or fear seek help / clarify misconceptions are likely also to have created a knowledge/epistemological gap (Arek-Bawa and Reddy, 2022; Gamage *et al*., 2020). Such "knowledge gap[s] … could eventually lead students to engage in acts of academic misconduct" (Gamage *et al*., 2020), which may have been the case for some students in the SoE. Since some form of virtual learning has come to stay, measures must be implemented to improve student engagement/attendance and strengthen the online assessment system.

The institution must strengthen online assessment integrity. The students could have resorted to dishonest assessment practices because they knew no one was watching. Despite numerous messages appealing to students' consciences, alerting them to the dangers/consequences of dishonesty, and signing a declaration of own submission, the problem persisted. Perhaps it is time for the institution to invest in virtual invigilation software to strengthen the integrity of the assessments and complement online education. Although it is highly expensive (Gamage *et al*., 2020), the benefits are also remarkable. Some courses, such as those with high theory content, can be facilitated and examined online without necessarily truncating the curriculum. Besides the reduced running cost to the institution, which can be passed down to paying students, and the elimination of in-house examination costs, it facilitates increased access which has remained a bane in the South African higher education space since the advent of democracy. This is particularly applicable to the institution's target market that predominantly hails from the poor socioeconomic background. With virtual learning, physical facility constraints are alleviated, and more students can live their dreams and increase the country's skilled labour force.

While some may contend that most students are from deep rural areas, some of whom have never interacted with digital technologies, we argue that they should be trained. After all, the core mandate of HEIs is undergraduate training (Jansen, 2021) to equip students with knowledge and skills to contribute productively to society. In this era, in addition to disciplinary content and pedagogical knowledge and skills, the SoE must equip students with

digital technological skills so that they can possess the relevant TPACK to thrive in their future classrooms and as global citizens of a bigger yet borderless world. This requires training in digital technologies from day one, which can be incorporated into the current orientation programme. Continuous training is also needed for the academic community to keep them abreast with various interactive pedagogical approaches that can be implemented in their virtual classrooms. It will not only engage students but keep the class meetings exciting (Mishra *et al*., 2020) and possibly increase attendance by attracting more students while enabling them with cross-functional skills for their 4IR classroom.

In the meantime, academics must continue to devise creative ways to engage and enhance students' attendance to achieve the desired objective of advancing education. Such academics manifested what Damşa *et al*. (2021) termed a transformative agency driven by the desire to accomplish set tasks in the constrained context and challenges associated with online learning. This was evident in the actions of Academic E, who met synchronously for all lectures, instituted measures to ensure regular attendance, ensured the credibility of assessments, and followed-up with faltering students to attain desired outcomes. In a sense, pedagogy took "primacy over technology" to further learning in the face of challenges/constraints (Peimani and Kamalipour, 2021: 13).

In response to the first Research Question (RQ), the quantitative evaluation revealed that academics in the SoE are quite confident that they possess the relevant technological, pedagogical, and content knowledge needed to prepare future teachers for their 4IR classroom. Regarding RQ2, the data from the quantitative study corroborated by the qualitative findings suggests that academics employed a blend of both passive and active pedagogical approaches in preparing teachers for their future classroom. Even though most of them commenced online teaching using passive approaches, they appreciated the need to engage students in the learning space and later devised different strategies to engage students more actively into the learning space. As such this paper concludes that pedagogical practices of academics in the SoE could have contributed to equipping future teachers with the requisite skills for future classrooms, albeit to a limited extent. Nonetheless, the qualitative findings revealed that academics were sceptical about the knowledge and skills that future teachers acquired from their digital learning journey. In response to RQ3, academics are not confident that students have acquired the relevant knowledge, skills, attitudes, and other behaviours to thrive in the future 4IR classroom.

Conclusion

This paper sought to explore academics espoused TPACK competence in preparing future teachers for the digitized 4IR classrooms using a mixed-method approach. Our findings revealed that academics are quite confident in their espoused TPACK competence which they employed in their virtual classrooms. Although some employed passive pedagogical approaches, especially at the start of online education, they appreciated the importance of engaging students in the learning process and strove for their participation. By so doing, they implemented a blend of both active and passive approaches in their virtual classrooms with fair chance of equipping students with the skills set of the 4IR. However, academics were not fully confident that their students acquired the relevant TPACK competence and other cross-functional skills, and knowledge needed for their future classrooms.

Besides electricity/network problems, attendance and assessments issues made it difficult for academics to vouch for the calibre of students produced from the online education experience. We argued that these issues are not unconnected with the epistemological gap emanating from the digital divide along socioeconomic lines exacerbated by online learning since most of the SoE students are from underprivileged backgrounds. With limited digital literacy and the anxiety associated with interacting with unknown digital technological platforms, students may have engaged less with the materials/lessons and easily resorted to dishonest assessment practices having access to limitless resources. As such, we advocate continued training for students and academics to improve digital literacy, making the former more comfortable with digital technologies and enabling the latter to keep up to date with various online active pedagogical approaches to attract and engage students. Also, the institution should invest in proctoring software to ensure the integrity of online assessments to complement online education which has considerable potential to increase access, thereby enhancing skills development in a country where the labour force is largely unskilled. Meanwhile, academics could exercise transformative agency to achieve the desired educational objective using available resources amidst the constraints of digital learning.

While rigorous efforts were taken to provide a rich understanding of academics' experiences in preparing students for the 4IR workplace, the authors acknowledge the following caveat: Being case based, the outcomes may not be

susceptible to generalisation, but the authors scripted a detailed description of the process and context to enhance replicability. In addition, the number of academics that completed the survey fell short of the recommended sample size despite extending the data collection period and repeated reminders. However, triangulated data from the interviews helped to corroborate the survey findings while offering rich data to answer RQ3. Thus, the research objective was attained. In the future, interested researchers with more time and resources could expand the sample size for a more robust understanding. Others can assess the enacted curriculum via a class observation and a review of the teaching, learning, and assessment materials to provide an eyewitness account of academics' practices in their virtual classrooms. Nonetheless, this paper offers valuable insights to academics in HEIs in general, specifically those in the SoE or in a similar context who pursue quality online pedagogical practices. Other researchers stand to gain insight from the knowledge produced in this paper while providing clear guidelines for possible replication in their context or extension as they deem fit. Policy makers can also be guided by the outcome of this study. It is also beneficial to programme managers and the SoE as they seek to produce teachers with the requisite skills for the digitised classroom while contributing to the literature on digital transformation in the 4IR learning environment.

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