A Fourth Industrial Revolution Paradigm Shift in Teacher Education?

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Abstract

This article explores the plausibility of shifting from the instruction paradigm to the learning paradigm in order to prepare teachers to meet the needs of 21st century learners within the fourth industrial revolution (4IR). While the instruction paradigm is dominated by teacher-centred instructional strategies, a shift to the learning paradigm would require teacher training institutions to prepare teachers who will facilitate the teaching/learning process through interactive strategies, that is, teachers who are 'meddlers in the middle', who create puzzling situations and work alongside students to construct knowledge. Key aspects of such a shift include training institutions' mission and purpose, criteria for institutional and personal success of teacher trainers and trainees, teaching/learning structures within institutions, learning theory, productivity, funding, and the nature of educational stakeholders' roles. In line with the dictates of the 4IR, training institutions should cultivate versatility to continuously identify, develop, test, implement, and assess effective learning technologies. In turn, their graduates should value learning as a continuous process for themselves, their learners, and their institutions.

Key words: Fourth industrial revolution, paradigm shift, teacher training, instruction paradigm, learning paradigm

Cet article explore la plausibilité du passage du paradigme de l'instruction au paradigme de l'apprentissage afin de préparer les enseignants à répondre aux besoins des apprenants du 21ème siècle dans le cadre de la Quatrième Révolution Industrielle (4IR). Alors que le paradigme de l'instruction est dominé par des stratégies d'enseignement centrées sur l'enseignant, un passage au paradigme de l'apprentissage exigerait que les institutions

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de formation des enseignants préparent des enseignants qui facilitent le processus d'enseignement/apprentissage par le biais de stratégies interactives, c'est-à-dire des enseignants qui se mêlent de tout, qui créent des situations déroutantes et qui travaillent avec des étudiants pour construire des connaissances. Les aspects clés de ce changement sont la mission et l'objectif des institutions de formation, les critères de réussite institutionnelle et personnelle, les structures d'enseignement/apprentissage au sein des institutions, la théorie de l'apprentissage, la productivité, le financement et la nature des rôles des acteurs de l'éducation. En accord avec les préceptes des 4IR, les institutions de formation devraient cultiver la polyvalence pour identifier, développer, tester, mettre en œuvre et évaluer en permanence des technologies d'apprentissage efficaces. À leur tour, leurs diplômés devraient considérer l'apprentissage comme un processus continu pour eux-mêmes, leurs apprenants et leurs institutions.

Mots clés: Quatrième Révolution Industrielle, changement de paradigme, formation des enseignants, paradigme de l'instruction, paradigme de l'apprentissage.

1.   Introduction

Industrial revolutions transform work, organisations, and many other aspects of daily life (Industry Insights, 2019), hence shaping the nature of education that prepares the population for socioeconomic transformation. Before the first industrial revolution, human socioeconomic activity was dominated by mainly agrarian and handicraft activities (Xu et al., 2018). Educational institutions were established to train a small elite to prevail over the masses (Xing and Marwala, 2017). The teacher education and hence teaching of the time favoured the *sage on the stage* pedagogical approach, with the teacher considered an expert who owned knowledge and transmitted it to students (Scales, 2019).

The first industrial revolution saw a shift in socioeconomic activity to industry and machine manufacturing (Xu et al., 2018), while the second was characterised by mass production facilitated by oil and electricity. This was followed by the third industrial revolution, in which production was automated by information technology (Xing and Marwala, 2017). These three industrial revolutions required that the scope of education be broadened to equip the masses with skills and prepare them for a wide variety of technical and economic roles. During this period, teacher education and teaching were called upon to address changes in institutional structure and function in terms of curricular, pedagogy, research, and service to the community. As an expert, the teacher was considered to be very knowledgeable and the pedagogical paradigm centred on teaching rather than learning. Instructional methods favoured teacher-centred didactic strategies. This is referred to as the instruction paradigm (Barr and Tagg, 1995) where the teacher serves as a 'sage on the stage' or 'guide by the side', implying that he/she knows it all. The learner is considered as a blank slate who is a passive recipient of knowledge from the teacher. At end of the process, learner achievement is measured against set objectives in terms of what they know, as opposed to what they can do. In such a system, the focus is on passing exams rather than on the core competencies attained through education. Teachers who graduate from such systems prefer to teach the way they were taught.

The world is currently experiencing a wave of "integration and compounding effects of multiple 'exponential technologies', such as Artificial Intelligence (AI), biotechnologies, and nano materials" referred to as the Fourth Industrial Revolution (4IR) (Penprase, 2018, p. 3). According to Schwab (2017), 4IR developments are affecting all disciplines, economies, industries and governments, and even challenging notions of what it means to be human. The Covid-19 pandemic has also disrupted socioeconomic activities and has had a major impact on education. Given that the global economy is moving towards widespread adoption of AI solutions (Butler-Adam, 2018), there is expected to be heightened competition for AI-skilled employees with the ability to implement, manage and work alongside the new technologies. Developing these competencies requires re-thinking or re-imagining of the education offered to student teachers who will teach learners skills that are relevant in an increasingly automated workplace. It calls for a shift from knowledge-based learning (the instructional paradigm) to competency-based learning.

As observed by Dahal (2019), every scientific innovation comes with both pain and pleasure. Learners taught by teachers under the instruction paradigm will not acquire sufficient competencies to match socioeconomic advancements. As such, they will demonstrate functional illiteracy in applying 21st century skills for development. Moreover, Mok and Jiang (2016) argue that ongoing massification which has led to the

privatisation of public education reflects a model of education that rewards students who memorise and master the same core curriculum. According to Mok and Jiang, such a system reflects a 20th century industrial economy characterised by factories rather than one powered by human creativity. It is training humans to compete with machines, which is at odds with the anticipated challenges of the 21st century.

The prevailing model of teacher education thus has to change and adapt to the new environment of the 4IR, where the academic exercise focuses on minimising the challenges and mitigating the harms the 4IR may generate. This calls for teacher education to shift from the instruction paradigm to the learning paradigm. The aim is to equip teachers with competencies to facilitate knowledge and meaning construction among learners. This will ensure that the education system addresses the needs of the 4IR society. This article offers insights on how critical aspects of teacher education should be rethought to ensure a relatively smooth shift from the instruction paradigm to the learning paradigm in the face of the 4IR. Its main argument is that the 'shift' does not imply totally discarding the instruction paradigm, but rather incorporating it in the learning paradigm. As advocated by Mazzucato (2016) and Cook (2016), governments need to lead by actively directing the economy toward new "techno-economic paradigms" which should be entrenched and reflected in the education system in general, and teacher education institutions in particular. Xu et al. (2018) note that the speed and measure of the changes brought about by the 4IR will result in shifts in power, wealth, and knowledge. They add that these changes can only be ameliorated by being knowledgeable and multi-skilled. Therefore, teachers need to be equipped to produce learners who can continuously construct knowledge and meaning with advances in technology

The Reality of the Fourth Industrial Revolution
The 4IR is characterised by a fusion of technologies that blurs the lines between the physical, digital, biological, and neuro-technological spheres (Balkaran, 2017; Lee et al., 2018; Xu et al., 2018). According to Schwab (2016), it is evolving in an exponential rather than a linear manner when compared with previous industrial revolutions. As it evolves, industries and trades in every country will drastically transform to match the changes. Ultimately, the breadth and depth of these changes will transform entire systems of production, management, and governance. A report by the World Economic Forum (2016, p. 5) notes that, "by one popular estimate, 65% of children entering primary school today will ultimately end up working in completely new job types that don't yet exist."

Dahal (2019) asserts that the 4IR will negatively impact jobs in the transportation, manufacturing and education sectors. Tirole cited in Aghion et al. (2017) believes that it will widen the wage gap between graduates of the instruction and learning paradigms. Penprase (2018) predicts that new 4IR technologies will include implantable cell phones, internet connected reading glasses, internet connected clothes, smart phones, internet traffic directed to homes and appliances, driverless cars, AI members of the board of directors, AI auditors and robotic pharmacists, proliferation of bit coins, 3D printed cars, and transplants of 3D printed organs such as livers. Such technologies require specialised competencies without which individuals risk losing out in the job market.

However, the World Economic Forum (2016) predicts net job growth overall, with as many as four new roles for each one lost. According to Lee (2018), the 4IR has the capacity to enhance the quality of life, enabling people to work less and better, with their wants and needs better met by more efficient production systems and digital platforms. Lee posits that with the advance of the 4IR, routine-based jobs will disappear, and organisations will employ individuals whose roles will be increasingly related to auditing activities and, most importantly, innovative and critical thinking. Iwuanyanwu (2019) argues that bold educational reforms and clear policies are required to realise these benefits, including among others the way teachers are equipped to prepare learners for the 4IR. Without these reforms, many people may lack the necessary skills to take up new positions in economies and societies that are anticipated to be fundamentally different.

The rapid shifts in technological development in the first, second, and third industrial revolutions are amplified in the 4IR. Dahal (2019) and Xing and Marwala (2017) are of the view that, given the mobility of learners, staff and programmes across national boundaries, higher education provision will need to occupy a virtual-real dimension. Teacher education and teaching will need to address the challenges of the complexity of cultures, technologies, demands, and mindsets that come into contact with one another in real time. Penprase (2018) observes that

earlier teacher education that placed a premium on capital based on land, water power, coal, oil and wood has to shift to a 4IR mode with a premium on intellectual capital, and capacity for collective thought. Students need to develop the ability to learn in diverse environments, and develop solutions in teams for the types of tasks that will be required of them in the 4IR. This implies that the teachers of this cohort of students need to be prepared in colleges and universities that develop more interactive forms of pedagogy at all levels.

Education should be geared towards lifelong learning so that when individuals are faced with unique situations, they are able to think critically and create solutions for development. For instance, in the face of the global Covid-19 pandemic, educational institutions in most countries have adopted various virtual learning strategies including radio and television programmes, social media platforms, and e-Learning platforms. However, there is limited adoption of these programmes due to, among other challenges, limited knowledge and skills in using technology, a lack of technological tools, and fixed mindsets that technology can't replace face-to-face learning (Manyiraho and Atibuni, 2021). Thus, in many developing countries, learners have ceased learning, exposing them to problems such as early pregnancy and antisocial behaviour (Plan International, 2020a, 2020b).

2.   Key Aspects of the Shift from the Instruction Paradigm to the Learning Paradigm

According to Xing and Marwala (2017, p. 10), "the fourth industrial revolution is powered by artificial intelligence and it will transform the needs of the workplace from task-based characteristics to human-centred characteristics." The authors add that the convergence of human and machine will reduce the content distance between the humanities and social sciences as well as science and technology. It is therefore critical that teacher education institutions realign their provision with the demands of the 4IR. As proposed by Lee (2018), institutions need to embrace technological advancement while recognising the centrality of people in organisational life outside of school. A shift in teacher education pedagogy is therefore a necessity to inculcate in teachers the most human-based distinguishing factors, including 21st century skills. They will then be better able to prepare learners who will be key drivers in creating and

delivering value within their societies.

Brown-Martin (2017) asserts that, given the challenges of the 21st century and the knowledge and skills that may be required to live well in the 4IR world, it is imperative to think of educating people differently. This calls for teachers who are proficient in technological, pedagogical and content knowledge (TPACK). Teacher trainees need to be equipped with skills and competences 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. The obvious challenge ahead, according to Iwuanyanwu (2019), is how to design new approaches to education so that students are prepared to navigate these new technologies.

Barr and Tagg (1995) propose that the shift should take into consideration the following main aspects: a shift in institutions' mission and purpose, criteria to measure and reward trainers and trainees' institutional and personal success, teaching/learning structures within institutions, the learning theory adopted in producing learning, issues of productivity and funding, and the nature of educational stakeholders' roles within institutions. This should produce learners with high levels of science, technology, engineering and mathematics (STEM) and digital skills as well as stronger social and collaboration skills to master the new 4IR machines.

Teacher Education Institutions' Mission and Purpose

The mission of the instruction paradigm is to ensure quality teaching by ensuring that the teacher is content-rich and able to didactically impress learners. During pre-service training, teacher trainees attain professional competence that their learners will benefit from in the teaching/learning process. As a result, assessment of trainees includes but is not limited to teaching practice and comprehension of subject content. In the instruction paradigm, trainers are also concerned with whether student teachers will be able to teach effectively, rather than whether the learners the trainees are practicing teaching with are able to learn effectively. While student teachers are obliged to acquire the education provided by teacher educators, the institution and educators are not in any way obliged to take responsibility to ensure that student teachers learn what they are being taught. As long as teacher educators do the bare minimum, the onus is

on prospective teachers to cram their way into the teaching profession. Such a setting generates a blame game; trainers blame trainees' poor ability and socioeconomic backgrounds for ineffective performance, while trainees and the community blame training institutions and trainers for ineffective training. Through the cascading system of knowledge and practice, this scenario is multiplied in schools where student teachers eventually become professional teachers.

Conversely, the mission of the learning paradigm is to 'produce' learning. As opposed to provide, support, or encourage, produce connotes responsibility on the part of the institution, trainers, trainees, and indeed all institutional stakeholders (Barr and Tagg, 1995). This implies that every member of the institution sets goals and acts to achieve them, continuously modifying behaviour to better achieve the goals. In case of ineffective performance, every member will identify their own contribution to the cause and try to modify their behaviour to prevent recurrence. The institution takes it upon itself to create an atmosphere and experiences that prepare student teachers to discover and construct knowledge for themselves. When they become professional teachers, they will structure their school environment to facilitate learning through the cascade system. In the learning paradigm, the focus is on assisting learners to make discoveries and solve problems as a community of learners, hence shifting from competitive to cooperative tendencies.

Real and imaginary problems are investigated within the learning paradigm and the 4IR competences of deep learning, critical thinking, the capacity for global communication, social networking, new technologies, and promoting and sustaining knowledge democracy are embraced (Xu et al., 2018). Both teachers and learners continuously identify, develop, test, implement, and assess effective learning technologies while imputing algorithms to auto-solve certain problems. Learning experiences go beyond institutions' boundaries; what the institution is lacking within its surroundings is outsourced, or study tours are organised to study and solve problems at their location. In other words, the learning paradigm aims to improve efficiency in addressing issues and to ensure that all are successful. Hence, the quality of instruction as well as learning for individual teachers and learners take centre stage.

Educators that foster the learning paradigm usually strive to teach by example through constant pursuit of knowledge, motivating student

teachers to follow suit. The virtues of persistence in acquiring relevant knowledge, skills, attitudes, and values are thus practically displayed and student teachers strive to acquire the same virtues in order to achieve their goals at the institution and later in work and life. Every member of the institution aims "for ever-higher graduation rates while maintaining or even increasing learning standards" (Barr and Tagg, 1995, p. 15). Unlike the instruction paradigm's focus on teacher educators' wellbeing and success, the learning paradigm is concerned with learning rather than teaching productivity. Recognition and scholarship schemes within the latter paradigm cater for both staff and students, with continuous improvement rather than achievement as a basis to reward performance. The learning paradigm thus contradicts the instruction paradigm's tenet that it is not possible to increase learning outputs without increasing resources.

Criteria for Teacher Educators and Student Teachers' Institutional and Personal Success

The instruction paradigm mainly rates the quality of education at the input level based on input resources. Institutions' quality is judged by comparing them with one another. A high quality institution is construed as one that employs the best teachers and enrolls the best grade students. The instruction process is characterised by learners cramming for examinations and questionable assessment processes (Kisekka, 2018). At exit, learners are likely to possess the same level of skills, values, and attitudes, while the knowledge they acquire is easily forgotten once the examinations are over.

Instructor evaluation criteria under the instruction paradigm include the level of organisation of lessons (lectures), content coverage, interest in and mastery of subject matter, preparation for lectures, and respect for learners' questions and comments. The instructor is mainly evaluated in terms of teaching without the need for evidence of learning. This paradigm is thus cluttered with teacher-centred instructional strategies, especially the lecture method.

Under the learning paradigm, the power of the environment or approach is judged in terms of its impact on learning. An environment that produces more learning is rated as more powerful. The learning outcomes include whatever the student is able to do as a result of a learning experience. Penprase (2018) states that learners are more learned and thus

4IR compliant when they are capable of creative insights, collaborating in diverse teams, and navigating global cultural differences. Such learners that become teachers will be a blessing to their own learners who are then at an advantage in a workplace that requires 21st century 4IR skills to achieve sustainable development.

Teaching/Learning Structures within Teacher Education Institutions

According to Barr and Tagg (1995), structures refer to features of an organisation that are stable over time, and that form the framework within which its purposes are achieved. Barr and Tagg note that they include the organogram, role and reward system, technologies and methods, facilities and equipment, decision-making norms, communication channels, feedback loops, financial arrangements, and funding streams. They posit that structural changes in the workplace impact the leverage applied by members of the organisation to their effort, and hence productivity and the nature of organisational outcomes.

The instruction paradigm structures within teacher education institutions are known to frustrate the best ideas and innovations of the new paradigm thinkers of the 4IR (Xing and Marwala, 2017). While the 4IR advocates for flexibility in combining different business models with customer access (e.g., production on demand; production on site; and consumer engineering), the instruction paradigm holds teacher education institutions hostage within a clock and calendar system. Instead of setting standards and 4IR structural adjustments for student learning, this paradigm sets schedules as the boundaries of student growth. Assessment is carried out by instructors and fails to reveal what students know and can do. Rather than addressing the problems of learning, the instruction paradigm generates more courses, classrooms, and departments, and increases fees in respond to teaching demands. This results in frustration as the imposed structures prevent students and staff from communicating with those in other departments and classrooms. The structures are fixed and immutable, and cannot be easily modified or altered.

A shift to the learning paradigm would enable institutions offering teacher education to refocus, re-imagine, restructure, re-engineer, and reinvent themselves to offer high levels of efficiency and effectiveness. It calls for structural and methodological adjustments to foster improved student engagement and success. The paradigm emphasises continuous redesign and evolution. Neither the ends nor the means are fixed; both are allowed to vary in the constant search for the most effective and efficient paths to student learning. Therefore, courses and lectures under the learning paradigm are regarded as dispensable and negotiable, and learning environments and experiences are flexible to accommodate students from all walks of life. Teacher education institutions that embrace this shift are likely to adopt learning methods and structures that produce the largest volume of learning outcomes in the most efficient and effective way.

However, structural adjustment within the learning paradigm is expected to commence and proceed gradually because many aspects of the instruction paradigm structures need to be modified. One of the key structures which, once modified, is likely to hasten the shift is an institution-wide assessment and information system to provide constant, useful feedback on institutional performance (Barr and Tagg, 1995). An effective assessment system is required to track a number of other structures, including student and staff mobility; graduation and completion rates; the flow of students through learning stages, and the development of in-depth knowledge in a discipline; the knowledge and skills of programme completers and graduates; and institution-level information such as annual graduation rates.

Assessment within the learning paradigm should shift to measure the amount and quality of student learning outcomes at entrance and intermediate level, and on completion of the programme. The knowledge, skills, values, attitudes, and competences that students are expected to acquire should be identified before designing the curriculum, educational experiences, and reliable assessment methods. Information acquired by means of the assessment should be used to redesign and improve learning processes and structures. In this manner, the learning paradigm becomes the bedrock to enhance the intellectual and social skills epitomised by the 4IR. Intellectual skills such as writing and problem solving, and social skills such as effective team participation are better achieved by learners when the learning rather than the instruction paradigm is adopted.

3.   Learning Theory

According to the instruction paradigm, knowledge consists of discrete units of matter known by a more knowledgeable other (teacher) who

dispenses or delivers it to learners (Barr and Tagg, 1995). The teacher is the chief agent of knowledge generation and transfer, while the learner is a recipient of knowledge for recall when demanded during tests. The paradigm thus dictates that control of learning activities is the domain of the teacher who is an expert in the field he or she teaches. Learners are given bits and pieces of knowledge in cumulative credit units. They are then tested and awarded certificates, diplomas, or degrees when they have accumulated a certain minimum number of credit units.

This splitting of and learning disconnected pieces of knowledge in subjects, branches, topics, and so on, is referred to as fractionated instruction (Farnham-Diggory, 1968). Farnham-Diggory showed that it results in learners forgetting what they have learnt, as well as inattention, and passivity as they are presented with disconnected routines, items, and sub-skills. Learning theories within the instruction paradigm reflect deeply-rooted societal assumptions about talents, relationships, and accomplishments: that which is valuable is scarce; life is a win-lose proposition; success is an individual achievement. The classroom setting sets learners up to be individualistic and compete with one another, with win-lose tendencies. Students are categorised and classified according to intellectual ability, which is a recipe for malpractice rather than promoting ethical conduct during the learning process.

A teacher who learns under the instruction paradigm cannot readily exhibit creativity to foster learning differently in the classroom, especially in the wake of the 4IR. Reversing this scenario would require teacher education institutions and teacher educators to adopt learning theories under the learning paradigm which regards learning as a holistic aspect of life organised around long-term goals (Farnham-Diggory, 1968). It considers the learner as the chief agent of the learning process. The paradigm assumes that human beings are born geniuses and designed for success, and that failure to display their genius or succeed is because their design function is being thwarted (Fuller cited in Barr and Tagg, 1995).

Under the learning paradigm, learners are active discoverers and constructors of their own learning. This implies that they need to create or construct frameworks of knowledge to appreciate that knowledge is not linear but rather a nesting of frameworks (Cyert, 2017). Thus, students' learning is demonstrated when they use their own frameworks to explain their understanding and to act. Learning environments and activities are learner-centred and controlled. Learners continue to learn whether or not there is a teacher, implying that every member of the institution is committed to the success of each and every learner. The work of the teacher is therefore to design learning experiences and environments so that learners can use them individually, through teamwork with fellow students, and with other members of society.

The theory of learning under the learning paradigm "promotes education for understanding" (Barr and Tagg, 1995, p. 8). This means that the learner will have a sufficient grasp of concepts, principles, or skills that can be brought to bear on new problems and situations. Education for understanding involves mastery of functional, knowledge-based intellectual frameworks rather than short-term retention of fractionated, contextual cues. Learning paradigm environments are challenging but cooperative, collaborative, and supportive; designed on the principle that accomplishment and success are the result of teamwork and group effort, even when it appears one is working alone.

Productivity and Funding

Under the instruction paradigm, productivity cannot be increased without diminishing the quality of products. It is defined as the cost per hour of instruction per student. Therefore, when the student-instructor ratio increases, productivity is threatened. Learning is generally prohibitively expensive in this paradigm, but more so in higher education. It has been proven to waste institutional resources as well as students' time and energy in registration processes, queuing for books and food, redundant courses, and other requirements. Rather than doing things in the most efficient and effective way, learners are conditioned to conventional structures in order to tune in to learning.

A shift to the learning paradigm would redefine productivity as the cost per unit of learning per student. The paradigm holds that it is possible to increase outcomes without increasing costs. The time students spend on registration, lectures, and queuing for meals and services will all be productive and will have a learning purpose such as training in critical skills, values, attitudes, and competences that should be acquired through such settings and processes. In the age of the 4IR, these processes are expected to become highly automated and such automation will become

more intelligent and self-adaptive as more advances are made in AI. This implies that teacher education institutions should invest more in STEM that are relevant to the demands of the 4IR (Penprase, 2018). The new breed of professional teachers should be able to produce learners capable of self-regulated learning that can be adapted to individual learners' demands and has self-learning capability. This will minimise unnecessary costs and time wastage.

Nature of Educational Stakeholders' Roles within Institutions

The instruction paradigm prescribes specific roles for each stakeholder in an institution. Members are not free to cross the boundaries of their terms of reference even if they are sufficiently competent to offer services outside their domains. The institution is composed of disaggregated experts who work in secluded areas of expertise, usually competing with and striving to outdo one another. Teacher educators in institutions characterised by instruction paradigm dictates are conceived of as experts in specific disciplines who impart knowledge to learners using teacher-centred strategies such as lecturing.

The 4IR agenda emphasises consistent digitisation and linking all the productive units in an economy (Xing and Marwala, 2017). Thus, all stakeholders in a teacher education institution become designers of the learning environment. They study and apply the best methods to offer services to enhance prospective teachers' learning. They embrace 4IR competences to produce learning and student success. Every member of the institution interacts with colleagues to foster teamwork. Therefore, all members are able and ready to cross the boundaries of their employment terms and offer useful support in disciplines originally construed as for others.

Learning paradigm teacher education institutions in the 4IR age will be characterised by the involvement of all members, increased accountability for learning, change in organisational control and command structures, increased teamwork, and shared governance. The structures of line governance and independent work will cease as hierarchies and competition will be devalued. Every member will be responsible for learning goals and technologies that maximise organisational output in terms of student learning. Therefore, cross-, inter-, multi- and non-disciplinary task groups and design teams will become the institution's

major operating mode.

Under the learning paradigm dispensation, prospective teachers should be able to progress through programmes and courses without necessarily having to interface directly with educators except at designated points. Learning goals and envisaged outcomes will be constructed by a composite team of disciplinary experts, information technology experts, graphic designers, and assessment professionals, all targeting trainees' success. The ultimate aim is to maximise student learning.

4.   Implications of the Proposed Shift in Light of the 4IR

Paradigms change when the ruling paradigm can no longer solve problems and generate a positive vision of the future. Changing paradigms means doing everything differently. According to the World Economic Forum (2017), the key question in the shift from the instruction to the learning Paradigm should be, "How can we do things differently if we put learning first?" This would require major shifts in vital aspects of education such as early childhood education, an employability curriculum, early exposure to the workplace and ongoing career guidance, a professionalised teaching workforce, digital fluency, robust and respected technical and vocational education, life-long learning, and openness to education innovation. However, there is a danger that if entered into light-handedly, the proposed shift could engender regurgitation of the old paradigm.

Barr and Tagg (1995) propose that this shift could be achieved by attempting to use the learning paradigm's tools and ideas within the framework provided by the instruction paradigm. Alternatively, intelligible information in the learning paradigm could be conveyed through the channels of the instruction paradigm. The focus should be the knowledge, skills, and talents graduates require in order to live and work fully; what students need to do in order to master the knowledge, skills, and talents; whether students are doing what is required to gain such mastery; and whether institutions provide experiences that help students to become competent, capable, and interesting people. The focus should also be on whether the students understand what they have memorised; whether they can act on it; and whether the college experience made students flexible and adaptable learners that are able to thrive in a knowledge society.

Areas of small change to create leverage for larger future change include the following: (a) Speaking within the new paradigm using

terminology that denotes learning rather than instruction, (b) assessing learning outcomes in the conventional classroom and growing slowly to programme and institutional levels, and (c) addressing the legally entrenched state funding mechanisms that fund institutions on the basis of hours of instruction. In the last case, policy makers need to be persuaded to fund colleges for results rather than seat time on the one hand, while tax payers need to pay for what they get out of education and get what they pay for on the other. Other implications of the shift in terms of specific activities within teacher education institutions are addressed below:

Teaching

Teacher education institutions should equip trainee teachers to learn through interactive strategies. In other words, teacher educators should serve as facilitators who are 'meddlers in the middle', with instruction or teaching merely serving as one of many means to achieve learning. It is therefore necessary to design teaching and learning experiences that foster learning. This would result in adaptable learning programmes, a better learning experience, and a culture of lifelong learning. Blended learning involving e-learning and face-to-face learning is suggested as one appropriate strategies to produce learning among prospective teachers. They should be guided to use both virtual and real environments to foster learning among their own learners. In blended learning, face-to-face teaching and evaluation can be used to develop analytical expressions and problem solving capabilities related to mathematical matters. Specific conceptual issues can be assessed and reinforced via online graphic representations and multiple choice test questions, which offer students the advantage of reviewing their results immediately.

Incorporating Assistive Devices in Teaching, Learning, and Training

Teacher education institutions have no choice but to incorporate assistive technological devices of the third industrial revolution such as cellphones, wearables, and tablets to enhance the teaching, learning, and transformation of teachers. These devices have huge potential to revolutionise the way teachers are prepared to handle similar situations in their future practice in schools. They will ensure that their learners use them to enhance learning. Short of this realisation, these devices, which can no longer be confiscated from learners, will be distracters rather than

enhancers of the teacher education process.

Training in Massive Open Online Courses (MOOCs)

The massification and internationalisation of education mean that students do not necessarily have to cross national boundaries in order to acquire the education of their choice. The 21st century teachers for the 4IR therefore need to be schooled in handling learners off campus and online. Teacher education institutions must invest more in MOOCs to eliminate the obstacles of physical proximity and productivity as is the case during the Covid-19 pandemic. Such investment would prove more economical as working off campus and online would enable institutions to enrol more students who would contribute more through tuition fees and subsidies.

Interdisciplinary Training

Given that the learning paradigm thrives in an environment of cross-, inter-, multi- and non-disciplinarity, prospective teachers need to be taken through a model of learning that emphasises teamwork. Furthermore, the limitation of confining student teachers to subject disciplines should be phased out. Instead, 4IR teachers must be trained in an inter-disciplinary environment where they should understand and be able to produce learning comfortably in all disciplines; humanities, social sciences, and core sciences. Penprase (2018) equally advocates for the retooling of STEM curricula in institutions to produce workers capable of advancing and accelerating the development of ever-more sophisticated biotechnology, nano-technology materials, and AI.

Community Service

To fully exhibit the relevance expected of modern education, teacher training institutions have to prepare teachers to produce learners who can offer service to the community. The training curriculum should have a full complement of the 21st century skills that graduates can foster in their own learners.

5.   Anticipated Challenges for Developing Countries

Islam et al. (2018) note that, by and large, developing countries lag far behind in the 4IR. Their study highlights significant challenges including poor infrastructure, the availability of cheaper labour, the high cost of installing technologies, a lack of government support and limited

knowledge. Industrial revolutions have been associated with increased levels of inequality in living standards, with the poor becoming poorer and the rich richer. There is also a fear that unstoppable 4IR proliferation could have negative consequences as was the case with the first, second, and third industrial revolutions which enabled more sophisticated technologies to kill people, and led to increasingly cruel and efficient political and military warfare. This implies that developing countries stand to become objects of a new form of colonisation, with their scarce resources dwindling even further. It also implies that the 4IR agenda is bound to face resistance from the disadvantaged who unfortunately can do very little, if anything, to avert its consequences.

Plausible Solutions

Butler-Adams (2018) and other scholars offer a number of possible remedies for developing countries to address these challenges. Plausible strategies include avoiding a proclivity to revert to the import substitution industrialisation programmes of early independence; employing systems thinking – operating in concert rather than in silos; rapidly improving access to electricity as a key policy priority; and being proactive in adopting new technologies. Butler-Adams maintains that 4IR AI needs to be contextualised to solve problems with increased efficiency, not just in manufacturing or planning but also in direct service to society. The work of scientists, policymakers, social workers, educationists and many others whose duty of care is to work for the achievement of sustainable development should be tailored to benefit from sophisticated AI applications. The goals may range from quality education, to decent work, climate action, affordable and clean energy and sustainable cities. Depending on the goal, important, valuable AI options already exist and more can and should be developed. This calls for teacher training institutions to equip teacher trainees with knowledge, skills and values for problem solving, critical thinking and lifelong learning which will in turn be passed on to their learners.

6.   Conclusion

Any educational plan for the 4IR must be built on the learning paradigm with a deliberate move away from the instruction paradigm. Teacher training institutions' services to 4IR teachers need to be structured in such a way as to embrace this fundamental paradigm shift so as to train teachers who will produce learning rather than those that are capable of teaching. Institutions should embrace and emphasise cross-, inter-, multi- and non-disciplinarity, accommodate virtual as well as real classroom settings, and aim to ensure that the learning that graduates will produce as practicing teachers is relevant to society. In line with the dictates of the 4IR encapsulated in 21st century skills, training institutions should cultivate in the teacher the versatility to continuously identify, develop, test, implement, and assess effective learning technologies against one another. With a shift to the learning paradigm, teacher training should prepare teachers that take cognisance of learners with different demographic characteristics. Teachers graduating from learning paradigm training institutions should value learning as a continuous process for themselves, their learners, and their institutions. The teacher's focus should be on learner success and sustainable development as the primary goal.

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