Complexities in the implementation of fourth industrial revolution tools to equip pre-service teachers in a South African university

Olika Moila, Andile Mji & Sibongile Simelane-Mnisi

Tshwane University of Technology
Gauteng, South Africa

ABSTRACT: The fourth industrial revolution (4IR) is creating predominant environments that have important implications for most universities globally. Hence, the purpose of this study was to scrutinise the complexities that hinder the use of these tools in equipping pre-service teachers in a South African university. A quantitative method was used, and entailed 70 pre-service teachers from three departments in the faculty of humanities of that university. Data were collected by means of a survey questionnaire, which was issued to all the participants. The data were analysed by means of MS Excel and presented in the form of frequencies and percentages. The findings revealed that students faced several complexities in developing the necessary knowledge and skills in the use of 4IR tools, and these included the non-existent or minimal 4IR tools, the need for more integrated teaching and learning, self-directed learning, and possibly external facilitation.

INTRODUCTION

The fourth industrial revolution (4IR) is characterised by a convergence of different technologies that are impeccably merging the physical, digital and biological spheres; hence, strongly impacting on the economic, social and education sectors.

Robotics, artificial intelligence, genomics, autonomous vehicles, mobile computing, smartphones, virtual reality, 3D printing, Internet of Things (IoT), quantum computing, peer to peer technologies, materials sciences, bioengineering, new energy technologies, digital currencies and the blockchain technology (BCT), metadata, analytics, crowdfunding, crowdsourcing, and more have had an immense impact on various aspects of life [1]. Hence, the 4IR is creating predominant conditions that have important implications for educational systems and universities are no exception.

In this regard, Gleason argues that higher education today is not just about producing graduates, it is about preparing *lifelong learners* [2]. In order to transfer 4IR skills to their students, educational systems around the world are enhancing their programmes to implement 4IR environments that are best for their students [2]. These technologies offer many exciting and distinct features in educational settings, and if effective in education, they can make an immense difference [3].

However, this is not the case at selected departments of a South African university involved in this study. Various complexities in the implementation of 4IR tools to equip pre-service teachers exist there, and these hinder effective preparation of students for the 4IR world. It is in this regard that the researchers embarked on this study in order to investigate the causes of these complexities; hence, giving recommendations for the departments directly impacted, and possibly to other educational institutions with similar issues, to enhance their practices with 4IR tools.

LITERATURE REVIEW

Research has indicated that in the 21st Century, innovative talent is much discussed and greatly valued, and that it is a worldwide phenomenon, and is consequent upon the development of knowledge economy and the progress of modern society [4]. These researchers further assert that the 2lst Century is a century of education, with great attention paid to the quality of students and education itself.

Virtual reality (VR) technology allows the recreation of non-existent objects of which there may be no trace remaining and allow access to digital models. Virtual reality technology is evolving quickly - from static visualisations through the presentation of 360° panoramic views to the presentation of parameters. Among developments is mixed reality (MR) technology enabling digital enhancement of real-world images [5].

The use of 4IR tools in equipping pre-service teachers is a form of inquiry-based learning (IBL), which is an active form of learning approach that can enhance student learning outcomes and develop inquiry skills that enable them *to learn assimilate information about a topic through self-directed investigation by progressing through different inquiry phases* [6]. Although the fourth industrial revolution is meant to embrace all the cutting-edge technology, and using it innovatively and creatively, it is difficult for the education system to fully participate in the 4IR in South Africa, when even the *digital revolution* or 3IR has not been fully integrated [7].

Many institutions in South Africa have not introduced technology into their schooling system, due to poverty constraints or the lack of funding [8]. However, it is imperative for South Africa as a country that its educational system keeps up with the advancements of the global community. All its educational systems need to keep up with the transitions of technology and adapt to the 4IR, and the university system in training pre-service teachers is no exception. In the old pedagogy, lecturers were expected to teach pre-service teachers how to interpret curricula through reading, writing and thinking [9]. However, in the 3rd, and more so the 4th industrial revolution, lecturers are expected to integrate technology into teaching and learning environments, in which pre-service teachers should be exposed to different types of sources; hence, discovering knowledge and interpreting concepts effectively [10].

The deepening of teaching reforms leads to innovation in teaching, with autonomous learning widely recognised as important. This is a way of creative learning by analysis, exploration, practice and questioning. In recent years, educational reforms have improved the integration of teaching content and the optimisation of teaching methods. However, students' practical ability remains relatively low [11]. Hence, the only way for pre-service teachers to adapt to the 4IR is for the lecturers to integrate 4IR tools into the teaching and learning activities [12].

RESEARCH METHODOLOGY

In this study, a quantitative research approach was used to investigate the complexities in the implementation of fourth industrial revolution tools to equip pre-service teachers through gathering numerical data, measuring variables with numbers and analytic statistics [13]. The study employed a purposive sampling as the subjects were expected to possess some relevant experience, knowledge and skills on the subject matter under investigation [14].

Questionnaires were used to collect data from 70 pre-service teachers at the university. A special questionnaire was designed to gather certain key factors probing complexities in the implementation of fourth industrial revolution tools to equip pre-service teachers, using a four-point Likert-type scale. The questionnaire was categorised into two sections, thus, biographical data and research statements. The biographical information entailed information, such as gender, age and the year of study.

The questionnaire contained research statements, 4-point Likert scale (e.g. 1 - agree; 2 - strongly agree; 3 - disagree; and 4 - strongly disagree) to tick one next to the statement. Further interpretation of the level of scales used in the questionnaire is displayed in Table1 below.

Table1: Interpretation of the level of scales used in the questionnaire.

Level of choice	Scale*	The nature of the responses
Agree	1	If the respondent is slightly influenced by the statement, X will be indicated on scale 1.
Strongly agree	2	If the respondent feels much influenced by the statement, X will be indicated on scale 2.
Disagree	3	If the respondent does not feel really influenced by the statement, X will be indicated on scale 3.
Strongly disagree	4	If the respondent is not at all influenced by the statement, X will be indicated on scale 4.

*Note: the numerical codes used reflect the bipolar character of the scale, but the numbers have been assigned in a non-standard way

The completed questionnaires were analysed through MS Excel 2016. Two different sections of the data were captured into different sheets. The biographical data of participants were captured into sheet A, which contained such information as gender, age, race and the year of study. Section B (sheet B) including the participants' statements was analysed using statistical techniques, and then presented in the form a composite table reflecting percentages and frequencies for reader-friendly interpretation [15]. The frequency was used to summarise how many times the characters appear in each category of the scale of measurement [16].

The researchers ensured that all the ethical procedures were observed in this research process. All involvement was voluntary, and the participants could withdraw from the process at any time if they so wished. The participants were also informed that their details would be confidential, and no names would be exposed. Furthermore, the participants would not be involved in a discussion of sensitive topics, which would involve invasive, intrusive or potentially harmful procedures. When collecting the data for this study, the researchers also adhered to the following ethical principles for researchers by:

- protecting the rights, interests and sensitivities of the respondents;
- reporting the research findings in a full, open fashion to the scientific community;
- striving to maintain objectivity and integrity in the conduct of the scientific research at all times;
- minimising the possibility that the results would be misleading;
- disclosing the research method used, and;
- recording data in a durable and appropriately referenced form [17][18].

It was of utmost importance that this study be academic in nature and that the outcomes be used to inform the relevant policymakers, as well as all other interested stakeholders about the complexities in the implementation of fourth industrial revolution tools to equip pre-service teachers at selected departments of one of the universities in South Africa. Recommendations based on these findings were used to pave the way for remediation [16].

RESULTS

The demographic data of the pre-service teachers who participated in this study were drawn through the first part of the survey questionnaire. This was done in order to better contextualise the results. Table 2 below represents the profiles of the participants.

Table 2: Profiles of the participants.

Gender	Female	Male
	49	21
Age	Between 18 and 20 years old	Above18 and 20 years old
	0	70
Study level	Year 2	Year 3
	38	32

Tables 3: Pre-service teachers' responses to the four-point Likert-scale questionnaire (3a-3j).

3a. Statement	There are adequate 4IR tools to equip students with the required skills		
Response item	Frequency	Percentage	Cumulative percentage
Agree	3	4	4
Strongly agree	2	3	7
Disagree	21	30	37
Strongly disagree	44	63	100
3b. Statement	There are challenges that I face in developing the necessary 4IR skills and knowledge		
Response item	Frequency	Percentage	Cumulative percentage
Agree	37	53	53
Strongly agree	29	41	94
Disagree	2	3	97
Strongly disagree	2	3	100
3c. Statement	4IR tools are integrated in the curriculum for my subjects by all lecturers		
Response item	Frequency	Percentage	Cumulative percentage
Agree	0	0	0
Strongly agree	0	0	0
Disagree	28	40	40
Strongly disagree	42	60	100
3d. Statement	I am satisfied with the 4IR opportunities given by the department		
Response item	Frequency	Percentage	Cumulative percentage
Agree	0	0	0
Strongly agree	0	0	0
Disagree	34	49	49
Strongly disagree	36	51	100
3e. Statement	Guidance is provided in the use of 4IR tools in my learning experiences		
Response item	Frequency	Percentage	Cumulative percentage
Agree	0	0	0
Strongly agree	0	0	0
Disagree	29	41	41
Strongly disagree	41	59	100
3f. Statement	Theory and practical activities systematically relate to the use of 4IR tools		
Response item	Frequency	Percentage	Cumulative percentage
Agree	3	4	4
Strongly agree	2	3	7
Disagree	19	27	34
Strongly disagree	46	66	100

3g. Statement	The skills and knowledge in the use of 4IR tools prepare the students to effectively teach at schools		
Response item	Frequency	Percentage	Cumulative percentage
Agree	37	53	53
Strongly agree	32	46	99
Disagree	1	1	100
Strongly disagree	0	0	100
3h. Statement	There is a need for the development of more 4IR-based and integrated teaching and learning		
Response item	Frequency	Percentage	Cumulative percentage
Agree	48	69	69
Strongly agree	22	31	100
Disagree	0	0	100
Strongly disagree	0	0	100
3i. Statement	The use of 4IR tools allows me to benefit from my own learning style		
Response item	Frequency	Percentage	Cumulative percentage
Agree	24	34	34
Strongly agree	42	60	94
Disagree	4	6	6
Strongly disagree	0	0	100
3j. Statement	The use of 4IR tools allows me to engage in the world alongside smart machines		
Response item	Frequency	Percentage	Cumulative percentage
Agree	23	33	33
Strongly agree	44	63	96
Disagree	2	3	99
Strongly disagree	1	1	100

CONCLUSIONS

Based on the findings showed in Table 3, items 3a to 3j above, there is an urgent need for the development of 4IR-based and integrated teaching and learning activities at the departments involved in this study; and 4IR tools must be used to allow students to benefit from their own learning. In higher education teaching reforms, attention should be paid to a high quality education, and the cultivation of practice and innovative ability [4].

In order to bring 4IR skills to pre-service teachers, the relevant departments in this university need to enhance their practices to implement 4IR environments that are most beneficial for their students. The 4IR resources should be readily available for all pre-service teachers and lecturers to access [3]. The researchers will further engage this sample through teaching and learning of their subjects, in which the use of appropriate 4IR tools will be experienced. This will be done in order to investigate whether or not the following perceptions of the participants given are indeed true:

- 99% of the pre-service teachers agreed that *the skills and knowledge in the use of 4IR tools prepare the students to effectively teach at schools* (item 3g); this aspect will be verified by means of observing these students during simulated teaching practice;
- 94% of these teachers agreed that *the use of 4IR tools allows them to benefit from their own learning styles* (item 3i) and;
- 96% of the pre-service teachers agreed that *the use of 4IR tools allows them to engage in a world alongside smart machines* (item 3j).

However, the researchers recommended that whilst they further engage in this study as indicated above, various departments within the faculty of education of this university need to involve external facilitators in the use of 4IR tools in order to develop new teaching and learning strategies. The envisaged result would be well-educated, socially cognisant citizens, well equipped with the skills for their era, in this case the fourth industrial revolution. There is a great need to embrace the use of 4IR tools in equipping pre-service teachers with relevant skills in order for the teachers to meet the expectations of this revolution. The pre-service teachers need to be moulded into *lifelong learners* rather than just graduates [2].

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