Development of Early Childhood Education Teachers in Information and Communication Technologies for Literacy or Pedagogy

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Abstract. This study aimed to establish how teachers were capacitated to integrate Information, Communication and Technologies (ICT) towards development of 21st century skills among Early Childhood Education level learners, in the Zimbabwean primary schools. This is in the face of a conglomerate of limitations based on teacher capacity, school culture and access to the ICT resources. The study employed an explanatory sequential mixed methods research design. Quantitative data was collected using questionnaires administered to 126 Early Childhood Development teachers drawn from 230 primary schools, followed by qualitative data collection through analysis of documents, focus group interviews and lesson observations with selected teachers. From analysis of quantitative and qualitative data through SPSS and ATLAS.ti respectively, it was found that teacher training colleges were strong in developing ICT literacy. However, they lacked the capacity to empower the teachers to integrate ICTs for instructional purposes. Such findings retard the achievement of the United Nations Sustainable Development Goals and the Zimbabwe Vision 2030. These goals regard ICTs as a cornerstone in the production of knowledgeable workers and qualified human resources for development of 21st skills among learners. Thus, the study recommends adoption of a model characterised by an institutional organisational context with organised internal and external support systems that facilitate sustainable provision of balanced technological, pedagogical and content knowledge for successful ICT integration in line with the national vision and global trends.

Keywords: Early childhood education; information and communication technologies; pedagogical practices; 21st century skills

1. Introduction
The need for integration of Information, Communication and Technology (ICT) in the curriculum the world over cannot be overemphasised. Any serious engagement aimed at developing the twenty-first century skills would be incomplete without the use of ICT. Technology is now the channel through which knowledge is transferred in most countries. Grabe (2007) asserts that technology has transformed societies in terms of the way they interact, produce goods and services as well as their ways thinking. Educational institutions, therefore, are obliged to adjust the way they interact with learners and integrate ICT as much as possible in order to meet the demands of the new world order.

The Zimbabwean education system, teacher training colleges (TTCs) included, has embraced the integration of ICTs as a cornerstone towards development of twenty-first century skills among learners, in line with the United Nations Sustainable Development Goal Number 4. However, as with other educational institutions in Zimbabwe, integration of ICTs in the teacher training programme in colleges, is implemented in an environment with some challenges relating to the capacity of teacher educators, access to ICTs and culture of TTCs among others. The ECE level is the foundation of all learning. It must, therefore, provide a strong base for development, learning abilities, lifelong learning and well-being for children. According to research, the success or failure of ICT integration for literacy and pedagogy lies in the teacher (Douglas et al., 2020; Masoumi, 2021). Therefore, this study set out to establish the extent to which the Zimbabwean early childhood education (ECE) teachers (teachers of pre-primary classes dubbed ECD A and B classes) are developed and supported to integrate ICTs for literacy and pedagogy (teaching and learning). Findings of this study were intended to offer a deeper insight into the current situation in Zimbabwe's teacher training and support programmes for the ECE level; to facilitate solid investment in ECE and craft intervention measures towards realisation of the United Nations (UN) Sustainable Development Goals (SDGs), especially goal number 1. The study therefore sought to answer the following research questions:
1. What provisions are available in the Zimbabwe teacher development programme to drive the ICTs integration agenda?
2. How do ECE teachers integrate ICTs in the primary school curriculum in Harare Metropolitan Province?
3. How are ECE teachers supported to enhance integration of ICTs in the primary school curriculum in Harare Metropolitan Province?

2. Literature Review
According to Khan et al. (2012), integrating technology in the curriculum is dependent on availability of the ICT tools, the level of technical expertise and an understanding of how children learn. In the same vein, Du Toit (2015) advocates for pedagogical training in using ICT in the classrooms. This means teacher professional development should equip pre-service teachers with skills to use applications and meaningfully engage learners. Curricula changes related to the use of ICT (including changes in instructional design) should also be realised. Pre-service teachers (or student teachers) should also be conversant with different technology tools and changes in teachers' role when ICTs are integrated in

learning and instruction (Jamieson-Proctor et al., 2013). Türel and Johnson (2012) assert that technical problems cause serious challenges to such integration. Issues like low connectivity, virus attacks and lack of printers will impede the development of skills. These should be addressed in pre-service teacher development programme and built on and enhanced by in-service teacher professional development. This diverts ICT teacher development focus from ICT literacy (instrumental skills) to using ICTs as instructional tools (pedagogical function) (Khan, et al., 2012; Bhalla, 2014).

According to Agbo (2015), professional development of teachers is at the centre of successful integration of technology in education programmes. In concurrence with Agbo (2015), Ra et al. (2016) found that professional development of teachers has a significant influence on how effectively ICTs are integrated in the school curriculum. As such, Prasad et al. (2015) state that research on the integration of ICTs in different educational settings identified the inability of teachers to understand why they should use ICTs and how exactly they can use ICTs for learners to learn better. Unfortunately, most teacher training in ICTs are heavy on 'teaching the tools' and light on 'using the tools to teach' (Musarurwa, 2011). This is supported by Hennessy et al. (2010) who found that when technology was introduced into teacher education programmes, the emphasis was often on teaching about technology instead of teaching with and through technology.

This study was predominantly underpinned by the Technological Pedagogical Content Knowledge (TPACK) model (Mishra & Koehler, 2006). The organisation aspect of the Technology-Organisation-Environment (T-O-E) model has been adopted to complement the TPACK model in guiding this study. According to the TPACK model, successful integration of ICTs in the classroom requires a balance of pedagogical, content and technological knowledge, which cumulate to facilitate learner optimal experiences (Ling et al. 2014), Technological Knowledge (TK) is difficult to delineate because of the changing dynamics of the ICTs accessible to the teachers and learners. In this study, this entails ICTs being available in the TTCs, and ECE classes in schools, to determine how they can be productively integrated. This concurs with Baker's (2012) assertion that ICTs at the educational institutions are central in determining the scope and pace of integration. Pedagogical Knowledge (PK) refers to the way in which the educator and/or teacher selects effective teaching and learning strategies, and how the content can be organised logically (Shulman ,1987). This aspect has assisted the researchers to investigate the PK which teachers are exposed to during pre- and in-service training programmes. Content Knowledge (CK) means the teachers' ICT literacy levels (instrumental skills) and actual knowledge about or expertise in the ECE curriculum. Drawn from the T-O-E model (technological context, organisational context, and environmental context that influence the implementation of a technological innovation) is the organisational context which denotes characteristics of an organisation (herein the school); such as its size, resources, degree of centralisation and managerial structure (Oliveira & Martins, 2011; Tornatzky & Fleisher, 1990 in Baker, 2012). This has motivated researchers to explore the impact of the following on ICT integration: teacher training programmes, the resources (material, financial and human) needed, and type of

the school (government, mission, council, and trust); which informs the managerial structure (staff responsibilities, internal communication structure and internal and external partners).

3. Methodology

This study employed the exploratory mixed methods research design (Creswell, 2014), following pragmatism as the paradigm.

3.1 Selection of participants

It is important to note that ECD A and B (pre-primary classes in Zimbabwe) are part and parcel of the primary schools. From the total population of seven districts in Harare Metropolitan Province, a sample of 230 schools was selected to participate in the study. This was done through stratified random sampling, so that identified types of schools (government, council, mission, and trust) were represented in the same proportion in which they exist in the population. The 126 qualified ECE teachers from the selected schools were purposefully selected for participation as they were deemed rich sources of data (Silverman, 2013) by virtue of having ICT at their schools and using them for learning and instruction.

3.2 Data collection

First, a questionnaire was designed to collect information on teachers' perceptions of what motivates and compels them to integrate ICTs in teaching and learning. The questionnaire was then administered to the 126 selected teachers. Through responses from questionnaires, teachers found with ICTs at their schools (rich sources of data), were targeted for involvement in focus group interviews, document analysis and observations. A focus group interview schedule was used to solicit data from 40 teachers selected in proportion to their representation (government, council, mission and trust schools). The focus group interviews allowed the researchers to probe for evidence, at the same time getting clues from the participants' body language with regard to integration of ICTs. To verify responses from the questionnaires and focus group interviews, a document analysis schedule was used to analyse school records (teachers' work books, staff meeting minutes, workshop reports and class inventories) of 12 teachers (randomly and proportionally selected from the sampled 40), on indicators of availability and use of ICTs; as well technical support to teachers on ICT literacy and pedagogy. Information obtained through the questionnaire, focus group interviews and document analysis was further verified through observation of the same 12 teachers teaching, whilst taking note of ICT tools used and those available in the classroom, methods employed and engagement of learners.

3.3 Data analysis

Quantitative data collected using questionnaires administered to 126 ECE teachers was analysed using SPSS version 26. Descriptive statistics were run and results revealed the teachers' perceptions about their ICT competences. Qualitative data collected using interviews, analysis of documents, and lesson observations were subjected to a combination of deductive and thematic analysis (Blum et al., 2020). Patterns and themes emerged.

3.4 Reliability and validity

Employing questionnaires, focus group interviews, document analysis and lesson observations facilitated triangulation of data collection methods and instruments. This enhanced the integrity of the findings.

3.5 Ethical issues

Prior to the research, an ethical clearance certificate was obtained from the institution where the research was conducted. Informed consent (Cargill, 2019) was sought from the teachers to ensure voluntary participation in the study.

4. Results

It was critical for the study to solicit evidence on the following: the extent of integration of ICTs in the teacher training programme and primary school curriculum at ECE level, teachers' competencies to integrate ICTs in the school curriculum, and as well as technical support availed to teachers in primary schools to enhance integration of ICTs.

4.1 Pre-service teacher training and integration of ICTs

In the questionnaire, teachers were requested to indicate specific ICT knowledge and skills they would have acquired during pre-service training (Figure 1).
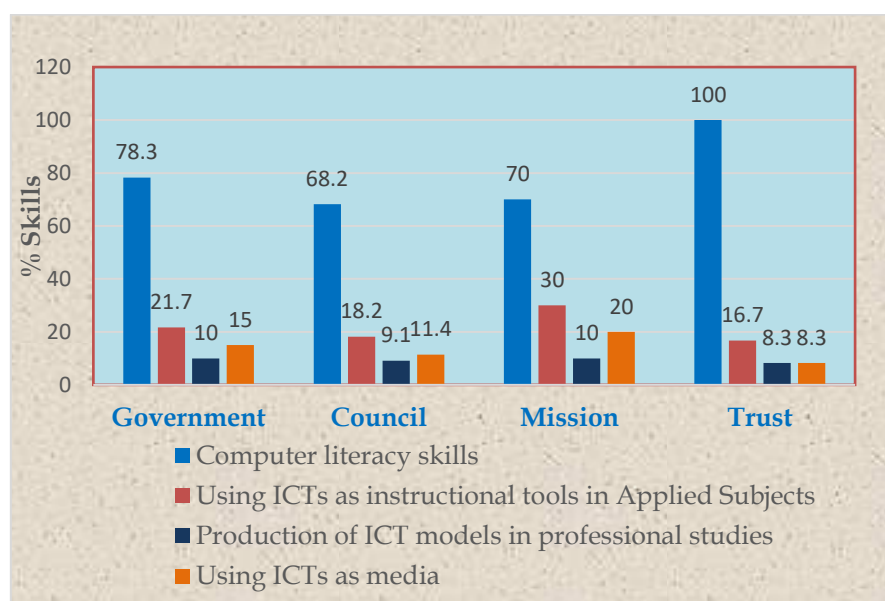

Figure 1: Responses of teachers on ICT knowledge and skills

Figure 1 reveals that 78.3% government, 68.2% council, 70% mission and all selected trust schoolteachers acquired computer literacy (computer operational skills) during pre-service training. These results showed that most of the teachers across government, council and mission schools were computer literate. All teachers from trust schools had technical skills to manipulate computers. This was

confirmed by school staff profiles and interviews with the ECE teachers. The following were some teachers' remarks during focus group interviews:

Mission schoolteacher: *I have done a computer studies course. I can source information from the internet, do word processing and make a PowerPoint presentation. But using these skills in teaching and learning different subjects, hey…I can't.*

Government schoolteacher: *It is critical for me to become ICT literate; given that I am supposed to use ICTs in teaching across subjects. I know how to operate computers and several other ICTs. The challenge is to use these operational skills to enable child-centred learning. We have to learn these skills.*

Figure 1 also indicates that very few teachers were trained to use ICTs as instructional tools in Applied Subjects (subjects taught in all the primary schools) regardless of the school type. These included Mathematics and Science, Physical Education and Mass Displays, Family and Heritage Studies, Visual and Performing Arts (Expressive Arts), Languages and Information Communication Technology. The results showed that during pre-service training, most of the teachers were not trained to use ICTs in teaching and learning. This was confirmed in face-to-face interviews with the ECE teachers as depicted in the following response:

Council schoolteacher: *My pre-service training helped me learn about computers. I most often use ICTs for routine tasks such as record keeping, lesson plan development, information presentation and basic information searches on the internet. I cannot use ICTs to engage learners.*

The figure also shows that a low average of 10% of teachers were exposed to production of ICT models in professional studies. Professional Studies is a course where student teachers are exposed to classroom practices that include the different methods to teaching different subjects at ECE level. These results showed that during pre-service training, not much was covered on application of ICT skills in the production of teaching and learning media. Analysis of documents and interview data also confirmed the teachers' lack of skills in production of ICT-based teaching and learning media.

Similarly, very few teachers used ICTs as instructional tools during teaching practice (work-related learning) in all the school types. Teachers gave different reasons for the limited use of ICT tools which ranged from scarcity of technological tools to teachers' lack of digital skills to effectively use the ICTs as instructional tools. This was captured in the following responses during interviews:

Mission schoolteacher: *I cannot be just using the computer in my teaching. I have heard about the projector, interactive board and digital camera but these gadgets are not available at our school. During pre-service training, I was never exposed to an ICT gadget other than the computer.*

Trust schoolteacher: *There is a problem of teacher training colleges producing teachers who can't use ICTs in teaching and learning when deployed at primary*

schools, whose ICT resources are better than the ones at college. I have mentored such a student teacher who had never seen a digital projector, interactive board and modem.

It emerged that the pre-service training of teachers was skewed towards computer literacy not ICTs in teaching and learning (ICT pedagogy). It was also observed that ICT tools available in ECE classes at school level, were not available at some TTCs.

4.2 ECE Teachers' ICT competencies

Using questionnaires, the researchers sought evidence on teacher ICT competencies in specific teaching and learning activities. These activities were reading, listening, watching a video, watching a demonstration and designing a presentation. The activities were as specified in the Education Management System Report (Ministry of Primary and Secondary Education [MoPSE], 2020). Figure 2 shows teachers' responses regarding their competencies in using ICT tools in teaching and learning of specific class activities.
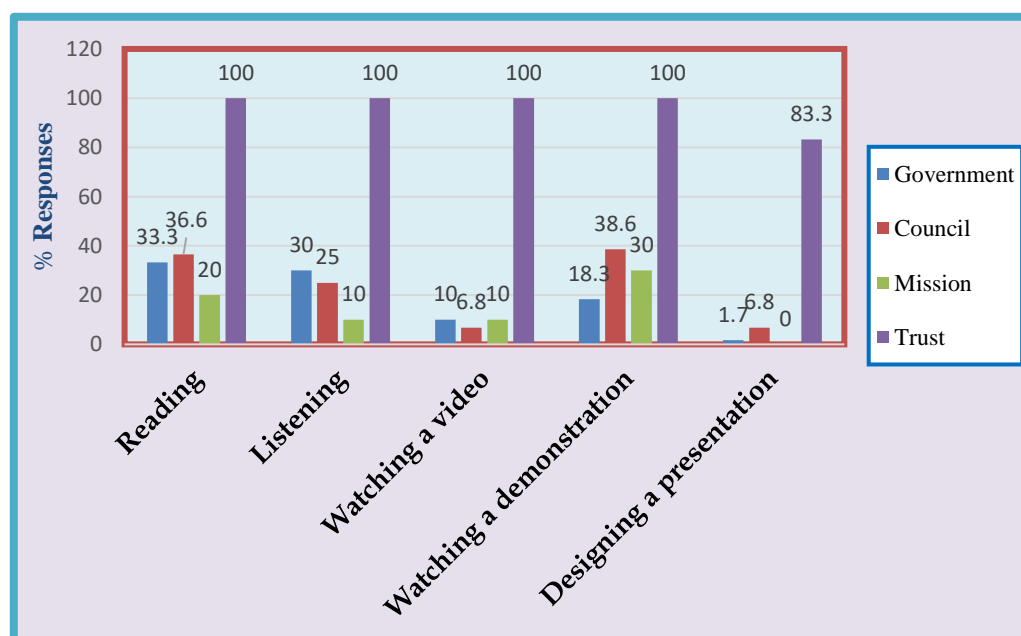

Figure 2: Responses from teachers on their ICT competencies

Figure 2 shows that trust schoolteachers were more competent to use ICTs in the different classroom activities (83.3-100%). This was however a complete opposite of what happened in the other schools which have quite low percentages (below 40%).

Through focus group interviews the researchers solicited information on how teachers from trust schools and the few from GCM schools obtained the competencies to use ICTs in specific class activities. The following were some of the responses:

Trust schoolteachers: *We can engage our learners in reading and listening tasks. They can practise pronunciation using on-line audio dictionary. They can make a recording of their own pronunciation. This whole learning process is exciting. We learnt how to engage learners in such tasks during in-service training funded by our school. We however perfected these skills through assistance from more competent colleagues at this school.*

Council schoolteacher: *At our school, we enrolled at a private college to improve our ICT skills so as to remain comparable to colleagues who are competent in using ICTs in their teaching. We succumbed to peer-pressure. This has transformed our teaching. We can use ICTs in some of our lessons.*

Government schoolteacher: *ICTs are excellent teaching tools. I got tuition from YouTube by myself. I have also been assisted by a friend, who teaches at this school. Now I integrate ICT tools in most of my lessons.*

From these results it was found that in some schools (trust schools), the school management made provision for teacher skills development so that they could be competent in teaching twenty-first century learners. Such in-service teacher development was important as pre-service teacher development failed to equip teachers with the necessary skills sets. In certain instances, teachers sought to seek development opportuinities themselves without the help of the school.

4.3 Availability of technical support to enhance integration of ICTs

ICTs are continuously evolving technologies such that even the most ICT proficient teachers need to continuously upgrade their skills and keep pace with the latest developments and best practices (Bhalla, 2014). As such technical support in both ICT literacy and pedagogy is crucial as this reduces anxieties associated with using ICTs in teaching and learning. According to the MoPSE (2015), teachers receive technical support from a specialist computer studies teacher stationed at every school to help learners acquire ICT skills; as well as a technician to help with computer hardware and software operations, and on-site maintenance of ICT equipment. The researchers analysed the school documents to establish if such technical support was available at the different primary schools. It was noted that the MoPSE had deployed one specialist computer teacher at each individual school to take up the computer lessons across ECE and junior classes. This, to an extent, helped to equip the learners with computer skills but some individual ECE class teachers (especially teachers based at government schools) encountered challenges in helping learners apply the acquired digital skills in learning different subjects.

Inversely, the specialist computer teachers lacked ECE pedagogy to adequately assist the ECE teachers to use ICTs in teaching different subjects other than computer studies. It also emerged that most trust schools had technicians but in some other school types, no technicians were employed. These results were corroborated by the responses from focus group interviews with teachers as depicted in Table 1.

Table 1: Responses of teachers on technical support

ECE Teacher From:	Response
Council School	*We do not have an ICT technician in post at our school.*
Government school	*Our computers are old. They break down quite often yet we can't afford hiring a technician.*
Trust school	*I benefit so much from the ICT technician. I can handle basic technical problems.*
Another Council School	*I wish I could train to handle some technical problems. The colleges that train these skills are expensive. I cannot afford … my school cannot sponsor me either.*
Mission School	*I cannot fix computers that break down. The school has also challenges to access cash to pay technicians for the job.*
Trust School	*We have frequent formal and informal on-site support from our school technician. I am not scared to use ICTs in most of my lessons.*
Another Council School	*We have a specialist computer teacher at our school. She only teaches computer studies lessons across the school. She is not an ECE teacher. So it is difficult for her to assist me with appropriate methods to teach my class using ICTs.*
Another Government School	*The computers at my school sometimes break down during lesson delivery. I don't know what to do. My lessons are disrupted. So, each time I plan a lesson using ICTs I must have a backup plan. This is not practical. As a result, I don't use the computers at all for fear that one or two might breakdown before I finish my lesson.*

Overall, teachers in the different types of schools concurred that technical support assisted them to confidently use ICTs in teaching and learning. However, teachers bemoaned the lack of technical support which undermined the effective use of ICTs in teaching and learning. Such a problem was attributed to failure by teacher training colleges to equip teachers with technical skills to use ICTs in classroom instruction and basic maintenance skills. This meant that a technician on-site was a priority. However, teachers at trust schools regularly received technical support at their schools.

5. Discussion

This research found that the pre-service teacher training programme was skewed towards ICT literacy rather than ICT pedagogy, which compromised the integration of ICTs during teaching and learning in the ECE classes at primary schools. This finding confirmed previous research in Zimbabwe which revealed that the pre-service teacher training programmes had shortcomings in developing teachers to integrate ICTs in teaching and learning (Konyana & Konyana, 2013; Mukwananzi, 2016). Thus, integration of ICTs requires a substantial pedagogical component in the Zimbabwe teacher training programme. Teaching ICT as an isolated discipline at TTCs, resulted in incompetent teachers when it came to integrating ICTs in teaching and learning of primary school ECE level learners.

It was noted that trust schools invested in empowering their teachers to use ICTs in teaching and learning. This was done through providing ICT tools as well as financing in-service training of teachers and teacher exchange programmes. This went a long way in ensuring the integration of ICTs in teaching and learning. Similarly, Muhammad et al. (2015) recommend that training programmes for teachers should take on board ICT pedagogical practices to acquaint teachers with

modalities on how to use ICTs in teaching and learning. The study found that the majority of ECE teachers stationed at GCM schools lacked ICT pedagogy. According to Ra et al. (2016), ECE being the foundation of all levels of education, should be handled by teachers who have sound ICT PK. Though the ECE teachers could manipulate computers, projectors and televisions among others, they could not facilitate learner-interaction with these ICT tools to grasp concepts and skills in different subjects. As a result, integration of ICTs for pedagogical purposes was undermined. This confirms the TPACK model which indicates that if teachers lack capacity, the implementation process suffers (Ling et al., 2014).

Some schools lacked ICT resources whereas others had resources, yet teachers were not equipped to use the ICT tools effectively. Previous researchers e.g. Tusiime et al. (2019) argue that ICT teacher pre- and in-service development programmes should be aligned with existing ICT resources at school level. The strategy adopted by trust schools to create an enabling environment for acquiring ITC skills is consistent with the T-O-E model (Li &Jerry, 2020) which underscores the relationship between ICT integration and the school's organisational context (resources and managerial structure).

In some schools, teachers did not receive in-service training on the use of ICTs in teaching and learning. This finding was a setback in the realisation of the Zimbabwe Government Vision 2030. This situation at these schools confirms Mlitwa and Koranteng's (2013) argument that the success of educational innovations depends largely on the mechanisms put in place to assist teachers sharpen their knowledge and skills in the execution of their duties. Similarly, Bordbar (2010) argues that teachers' pedagogical technology competence is a major predictor of integration of ICTs in teaching and learning. Overall, the Zimbabwe TTCs failed to facilitate provision for equal opportunities for learners enrolled in different schools, in terms of integration of ICTs in teaching and learning. This was contrary to the Zimbabwe Education Act (1987) as amended (2020) and SDG 1 which emphasises access and equity to education for all learners.

The study also found that some schools did not have technicians in post to provide technical support to teachers. Technical support includes technical skills to use ICTs in classroom instruction, basic maintenance and upgrading of ICT hardware and software. The technical skills could be acquired through regular intra- and inter-school and national staff-development workshops/programmes. According to Karimi (2011), technical support to teachers should be on-going as ICTs continuously develop such that teachers can be outpaced by the dynamism of the technologies. This is affirmed by Tusiime et al. (2019) who state that successful integration of ICTs in education depends on the continuous professional development of teachers. This demonstrates the need to strike a balance between ICT literacy and pedagogy as advocated by the TPACK model (Baker, 2012) during both pre- and in-service training of ECE teachers.

6. Conclusions and Recommendations

The findings of this study showed that development of ECE teachers in ICTs integration was skewed towards ICT literacy rather than pedagogy. When ECE teachers were deployed to primary schools after training, they found themselves relatively incompetent to engage learners in ICT-based learning experiences. This is contrary to the UN SDG 1 and Zimbabwe Vision 2030 specifications, where ICT is the cornerstone for learners' acquisition of 21st century skills.

It is important to note that the ECE level lays the foundation for the future education of learners. The teacher training programme should ensure that teachers develop competencies to facilitate ECE learners' acquisition of twenty-first century skills. More so, the ICT provisions at TTCs should match those available in the primary schools.

The researchers recommend the adoption of a combination of the organisational context of T-O-E model and the TPACK to produce the Organisational Context-Technological Pedagogical Content Knowledge (OC-TPACK) model as shown in Figure 3.
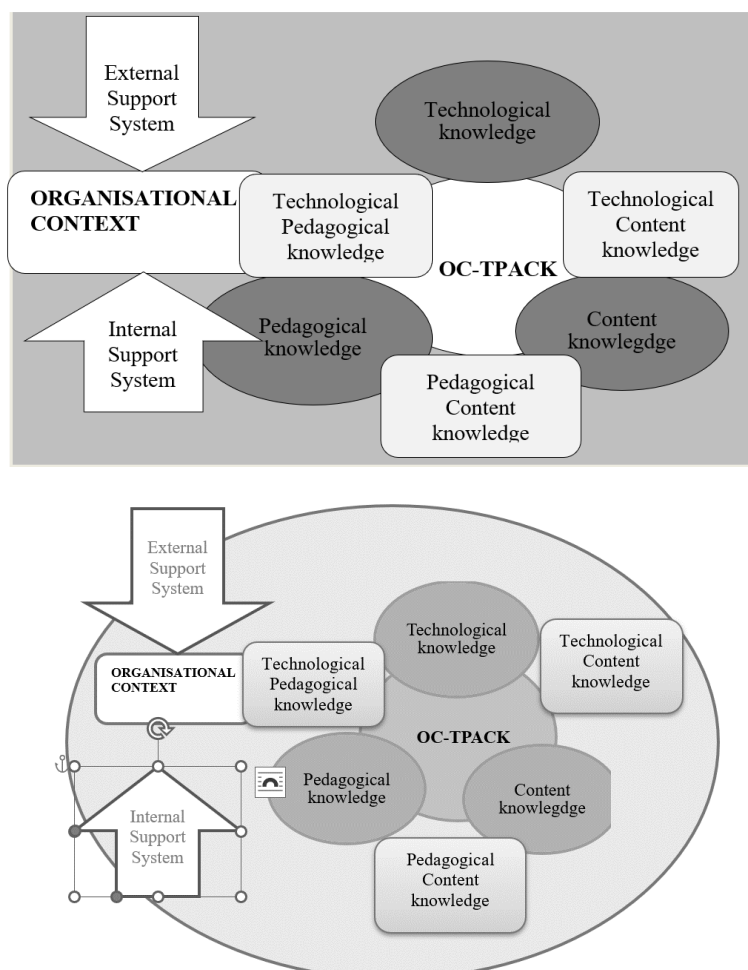

Figure 3: Proposed OC-TPACK model for ICT integration

Therefore, there is need to transform both the pre- and in-service teacher training programmes for ECE teachers, to strike a balance between ICT literacy and

pedagogy as advocated by the TPACK model. The government should create an enabling environment to ensure equal and equitable access to ICTs, including the emerging technologies to bridge the digital divide among the different school types. Likewise, schools should transform their organisational context (T-O-E model), so that they have sustainable internal and external support systems to ensure integration of ICTs, as is the case at trust schools. The internal support systems could include income-generation projects and school-community partnerships to systematically fund provision of ICTs, upgrade and repair of ICTs, and teacher capacity building. The external support systems could include partners from local industry, individual entrepreneurs and international organisations.

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