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Adopting a Hexagonal Inter-Activity Model for Integrating Digital Technologies in South African Secondary Schools

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Abstract. The study investigated how Digital Technologies (DT) are integrated at South African public schools. Only one official who oversees DT integration in schools, eight principals, eight DT coordinators, and 300 teachers from selected schools were purposefully chosen for the study. There were 24 teachers and one district facilitator who participated in in-person interviews. The survey questionnaire was completed by 191 teachers. Quantitative data was analysed using Microsoft Excel and displayed as frequencies and percentages. The interview responses were recorded, transcribed, analysed, and presented in narrative descriptions, verbatim. The findings indicate that the teachers lack the necessary abilities to incorporate DT into teaching and learning activities and had little training on how to use DT for teaching. The results suggest that while DT policies exist, the schools have not yet achieved a satisfactory level of implementation. To solve the present, the researchers advise implementing the hexagonal interactivity model of Digital Technology Teacher Professional Development (DTTPD). The following aspects may be enhanced by this model: The most promising approaches are included in the model, including a team-based approach (division of labour) and continuous training that prioritises real-world application for the community/schools; 1. The availability of adequate training regarding the use of DT in the curriculum; 2. Effective DTTPD planning; 3. DT support (technical and resource); 4. The teachers must be aware of how technology may enhance teaching and learning processes rather than merely obtaining theoretical training without practical support, which will result in a knowledge implementation gap in the field.

Keywords: digital technologies; teaching and learning; integration; public secondary schools; teacher development program; hexagonal interactivity structured model

1. Introduction

The adoption of Digital Technology (DT) for teaching and learning is revolutionising most educational systems, including the ones in South Africa (McCarthy et al., 2023). There has been a lot of interest in using these tools for teaching and learning in South Africa for the past 30 years or more. Accordingly, to date, the Department of Basic Education (DBE) and other stakeholders in South Africa have had various policies and initiatives that were envisaged to enhance the teachers' and learners' Information and Communication Technologies (ICT) confidence and creativity, including but not limited to the development of the skills and knowledge needed to achieve personal goals and to be full participants of the global community (Gustafsson & Nonkenge, 2025). In the last few years, there have been incredible DT innovations which include the introduction of tablets, laptops, and interactive smart boards for the high schools. However, there is significant concern that these resources, as well as relevant professional development on their use for teaching and learning have not yet been equitably accessed by all South African schools (Moila et al., 2022).

The researchers note that one of the primary problems is that there is currently a discrepancy in the availability and use of DT resources for teaching in the South African classrooms. Despite the quick acquisition of ICT infrastructure and hardware by the schools, the teachers continue to express dissatisfaction with the calibre of training offered to facilitate the use of these technologies (Kirui, 2023). Finding an efficient staff development model that can influence the teachers' use of DT to support teaching and learning was the primary focus of the current study. The study was motivated by the need to investigate how DTPD may improve the teachers' expertise, self-assurance, and ability to use DT tools, which would ultimately result in a more frequent and effective use of these tools for teaching. The paper also describes, explains, and theorises the anticipated changes in the teachers' practices when the TPD model is adopted.

2. Review of literature

Studies such as those by Good (2020) assert that educational technology is full of glowing promises of dramatic and meaningful improvements to classroom activities and outcomes in the 21st century. It is in this regard that in this section the researchers present a brief overview of the vast amount of literature that investigated and suggested beyond reasonable doubt that DT has endless benefits in education. According to research, DT helps to change a classroom setting into one that is learner-centred as the learners are actively involved in the learning processes and are minimally guided by the teacher to take ownership of the learning activities (Huang et al., 2024). As a result, DT offers more educational affordances and opportunities to both teachers and learners than traditional teaching and learning settings. These tools help to change a classroom setting into one that is learner centred. This view is also echoed by Kurt (2021) who maintains that the classroom can be reorganised and redesigned using DT to create an atmosphere that encourages the growth of higher order thinking abilities. Additionally, it has been suggested that DT fosters learner collaboration, which is a very powerful learning tool because it allows the learners to collaborate and learn from one another (Awidi & Paynter, 2024).

As a teaching and learning tool, DT provides; nearly limitless opportunities for communication, the introduction of novel concepts into the classroom, as well as the retrieval, manipulation, creation, and presentation of information (Taylor & Marino, 2024). There is ample support for the claim that whilst DT is revolutionising the way the 21st century natives live; these resources are not problem-free. To this end, Mercader (2020) identifies a number of obstacles of the integration of digital technology in the schools, such as the insufficient hiring of technical support staff, the lack of time for the teachers to prepare lessons mediated by digital technology, the lack of collaboration among the teachers in this regard, the lack of assistance from school administrators in resolving the teachers' concerns about digital technology, as well as the lack of training and guidance for the teachers on how to incorporate these tools into teaching and learning activities. Furthermore, despite multiple efforts to equip the teachers with DT knowledge and abilities, it has been noted that the teachers have persisted in complaining about the lack of relevant and helpful DTTPD (Fernández-Batanero et al., 2022).

Hence, in this study the researchers considered that examining the TPD models was extremely important to draw consensus from research about what practices support the TPD models, and these included the teacher development model (DoE, 2007). This model entails the following stages:

- Entry level: The teacher can operate a computer and is computer literate. However, when ICT is introduced, frustrations and fears are prevalent. The teachers at this level are probably insecure.
- Adoption level: The teacher can teach learners how to use ICT and can assist with traditional management, administration, teaching, and learning using a variety of ICT, including computers.
- Adaptation level: In addition to assessing learning and guaranteeing progress, the teacher can use ICT to enhance regular classroom activities at a level adequate for the National Curriculum Statement (NCS). The teacher can also use ICT systems for management as well as administration and can critically reflect on how ICT alters the teaching and learning processes. At this level, productivity rises.
- Appropriation level: The teacher has a comprehensive grasp of how ICT enhances teaching and learning. The evolving nature of ICT is recognised, as is a fact that it is essential to the goals and structure of the NCS. The teacher possesses the expertise and self-assurance to consider how ICT can impact teaching and learning methods as well as implement innovative approaches.
- Innovation level: The teacher can develop entirely new learning environments that use ICT as a flexible tool, so that learning becomes collaborative and interactive. ICT is integrated as a flexible tool for school development through redefining classroom environments and creating learning experiences that leverage the power of technology.

The study identified certain shortcomings in the teacher development model, even though it calls for the teachers to possess extremely high levels of digital technology proficiency. This study was conducted because most of the specified

criteria had not been fulfilled at the time the research project was started. The model is devoid of information regarding "how" the TPD process should proceed, "who" should be involved and at what point, and "when" the process should be put into practice. Amongst numerous researchers who have investigated the factors that affect DT integration in education, Valverde-Berrocso, Fernández-Sánchez, Revuelta Dominguez and Sosa-Díaz (2021) note that some conditions such as related infrastructure, seem to be absolute requirements for DT to be used in the classrooms. Some of these requirements including but not limited to the access to ICT, available time, and curriculum flexibility, are unlikely to be influenced by TPD (*ibid*).

The continuum teacher professional development model was also examined in detail in the study (Majumdar, 2009). According to the study, a suitable model for integrating ICT and pedagogy in TPD should include at least four general strategies that the educational systems and particular institutions must normally follow when adopting and utilising ICT.

- The developing approach can be seen in the schools that are only starting to develop ICT. These schools have a basic computing infrastructure that the school administration has either bought or received as a donation. During this first stage, the teachers and managers investigate the potential benefits and drawbacks of integrating ICT into the curriculum and using it for school administration. The teachers and learners learn about the ICT tools and their general purposes during this first phase. Basic skills and ICT literacy are typically prioritised.
- Applying stage: The applying method is best represented by the educational institutions where a fresh perspective on the role of ICT in education has emerged. The teachers and administrators use ICT in this secondary phase to complete duties that have previously been completed for the curriculum and school administration. The learning environment is mostly controlled by the teachers. With specialised software and tools including sketching, designing, modelling, and application-specific tools, the schools in the applied approach phase modify the curriculum to boost the use of ICT in a variety of subject areas.
- Infusing stage: The schools that currently use a variety of computer-based technology in laboratories, classrooms, and administrative offices are demonstrating the third step of the infusing strategy, which entails integrating or embedding ICT across the curriculum. To represent real-world applications, the curriculum starts to integrate academic areas. According to the infusing approach to ICT development, ICT permeates every facet of the teachers' work life to enhance learning and learning process management. This phase entails knowing when and how to use ICT technologies to accomplish specific goals, such as finishing a project. This stage denotes the capacity to identify circumstances in which ICT will be beneficial, selecting the best tools for a given activity, and applying these tools to address actual issues.
- Transforming stage: This fourth and last stage involves specialising in the use of ICT tools which occurs when one enters more deeply into the learning environment that creates and transforms the learning situation with the help

of ICT. This is a new way of approaching a teaching and learning situation as it uses specialised ICT tools and is linked with the transformation stage in the ICT development model. This final stage involves specialising in the use of network-based resources to create meaningful environments that create and transform the learning situation.

According to the researchers' critique of this approach, it may work well because it makes clear the potential DT capabilities that are anticipated for each level. The model, according to the researchers, is flawed since it is unclear how expert supervision, and collaboration should affect the anticipated shift in teaching techniques brought about by TPD. Additionally, it does not specify if it is policy for collective schools to participate in TPD. However, the phases of innovation, appropriation, and adaptation should not be viewed as the only indicators of a teacher's proficiency. According to research, DTTPD must encompass much more than just computer literacy training. The teachers must be able to access and manage information, create, and modify content materials to meet the requirements of the learners, and understand the merits and demerits of using DT for teaching and learning (Haleem et al., 2022). Similar views are expressed by Fernandes et al. (2020), who contend that the professional development programs that prepare teachers for the successful integration of digital technology in a constructivist classroom setting must go beyond the scope of conventional PD programs and assist in establishing the links between the PD program, own learning and classroom activities.

3. Theoretical framework

Finding a framework to understand this trend was essential because the educational landscape is always changing in terms of both teaching approaches and the expectations for learners. Therefore, the five tenets of the Learning and Activity Theory (EL and AT) postulated by Engeström and Sannino (2021) served as the foundation for this investigation. Learning new activities as they are developed is related to the expansive learning theory (ibid). Collective transformation, as opposed to individual learning, is another aspect of the EL and AT. According to this study, the way the teachers use digital technologies in the lessons is anticipated to change because of the modifications made to the DTTPDPs in the schools. The five principles of the activity theory postulated by Engeström & Sannino (2021) include the possibility of expanded transformation, conflicts, historicity, multi-voicedness, and the main unit of analysis. The primary unit of study is a collective, object-oriented, artifact-mediated activity system as observed in its network relationships to other activity systems (Engeström & Sannino, 2021). The efficient use of DT (artefacts) for teaching and learning activities was the focus of this study, and the way these tools were used in accordance with the educational expectations of the 21st century was verified. An activity system is usually a group with a variety of viewpoints, customs, and interests when it comes to multi-voicedness.

This study investigated how the division of labour and multi-voicedness in the DTTPDPs affected the schools. To gain clarity on the present DTTPDPs statuses and implementation at the eight schools, individuals from a variety of positions

and levels were engaged. Activity systems that develop and change over extended periods of time are considered as historic. The only way to comprehend the issues and possibilities was to compare them to the past. The history of these participants' DTTPDPs and degrees of integration in the practices were examined in this study. Since contradictions have historically accumulated structural tensions both inside and between activity systems, they are important sources of development and change. To successfully eliminate or at least reduce the existing gaps, this study investigated and attempted to comprehend the relationship between digital technology regulations, TPD, infrastructure, accessibility, and the availability of resources.

4. Research methodology

To produce descriptive and explanatory information that would aid in learning at the chosen public secondary schools in South Africa, the researchers used a case study technique within a multi-method research paradigm. In this case study, the researchers examined a bounded system using a sample of public secondary schools in South Africa as a method, object of inquiry, and description (Chowdhury & Shil, 2021).

The integration of digital technologies at the chosen public secondary schools in South Africa was investigated in this study using a Mixed Methods Research (MMR) technique. Its methodology was centred on gathering, evaluating, as well as combining quantitative and qualitative data. The fundamental idea behind MMR's application was that combining quantitative and qualitative methods would improve the comprehension of the study issues (Ivankova & Clark, 2023). A total of three officials from a DBE district who oversee DT integration in the schools, 108 principals and 2 347 teachers from 108 public secondary schools in South Africa made up the research population in this study. Both convenience and selective sampling methods were used in this investigation. Because the sample was made up of items with the most typical, representative, and characteristic qualities that suited the study's objectives, the researchers used intentional sampling (Ahmad & Wilkins, 2024). However, because the researchers could easily reach these schools, convenience sampling was also used, which saved time and money by ensuring that the respondents were readily available (Golzar et al., 2022). To get particularly valuable and pertinent data that allowed the respondents to answer the study questions and create well-founded arguments in favour of the findings, the researchers chose the respondents in a non-random manner (Hunter & Rodriguez, 2021). This approach raised the possibility that the entire spectrum of different realities would be discovered as well as the breadth or range of data that was disclosed. The targeted study's sample included 300 teachers from the designated schools, eight principals, eight DT coordinators, and one official who oversees DT integration in the schools. Semi-structured questionnaires (see Appendix 1) and structured interviews (see Appendices 2 and 3) were the primary tools utilised in this mixed-method study. These various methods of data collection can support one another and increase the reliability and validity of the results (Ajideh et al., 2021). All 300 school-based teaching staff members from the participating schools were given quantitative data. Nevertheless, 191 (64%) of the completed surveys were sent back. Since it

would have been against their right to decline participation, the researchers were unable to convince the others to return the questionnaires. A total of eight ICT coordinators, three ICT managers and 24 instructors from the eight schools were interviewed for this study using semi-structured questions. Interviews are thought-provoking, give participants the opportunity to express themselves more fully, and inevitably as well as profoundly generate meanings that are likely to exist within the participants, thereby revealing additional information that the researchers may not be aware of (Wu et al., 2023).

Legitimising the data was crucial because it ultimately increased the study's research report's credibility. Therefore, to make sure that the quantitative tool (questionnaire) consistently measured what it was expected to, the researchers used the statistical Cronbach's alpha in this study. The reliability coefficient of Cronbach's alpha typically falls between zero and one. The internal consistency of the scale's items increases with the Cronbach's alpha coefficient's proximity to 1.0. The reliability coefficients that fall between zero and eight (rounded to one decimal place) are generally considered as acceptable (Santos et al., 2021). To do this, these researchers offered the following guidelines about the relevant coefficient: Excellent is defined as greater than .9, good as greater than .8, acceptable as greater than .7, questionable as greater than .6, poor as greater than .5, and unacceptable as less than .5. Accordingly, the study's alpha coefficient was 0.778377, falling within the range that Santos et al. (2021) considers as acceptable. Nonetheless, the Cronbach alpha coefficient is typically reported accurate to one decimal place. As a result, the study's alpha coefficient was 0.8, suggesting that the scale's items have acceptable internal consistency.

Several steps were taken to guarantee the instruments' authenticity. A peer involved in the study process first evaluated the questionnaire and made important suggestions (Riazi et al., 2023). Peer reviewers help, act as an advocate, examine the researcher's presumptions, encourage the researcher to proceed, and pose insightful queries on the employed methodologies and interpretations (Erviana et al., 2023). Establishing the credibility of the study's findings required both making sure the research was conducted in accordance with good practice guidelines and presenting the findings to the participants for verification that the researcher had understood the respondents correctly (Akram et al., 2021). After the interviews were transcribed, the researchers checked the scripts' content with each respondent to make sure the conclusions and interpretations accurately represented the opinions.

Each respondent was given the opportunity to answer the questions in-depth by the researchers, which produced detailed descriptions of the phenomenon being studied and supported transferability (Chen & Baptista Nunes, 2023). When assessing and interpreting the information gathered from the interview sessions, the researchers tried to be objective. The researchers' personal theoretical beliefs and values were not allowed to affect how the study was conducted or the conclusions (Bell et al., 2022). As a result, the researchers meticulously documented every interview and made sure that all the submitted information for the study was handled in confidence.

The quantitative data was analysed using Microsoft Excel. To make statistical data clear, controllable, and understandable, the researchers employed explanatory techniques to characterise, analyse, and condense the data into key study features without omitting or distorting important information (Gawali, 2023). The researchers evaluated the quantitative data based on the many themes of the measuring device with the goal of processing the data in the end (Roefs et al., 2024). Frequencies and percentages were used to display the data for easy interpretation by the readers. To support or contradict the previous findings pertaining to this study, the researchers additionally connected these findings to the evaluated literature. This was done in a way that neither confirmed nor refuted the opinions of the different researchers that were covered earlier in this study's literature analysis. Based on the data summary, statistical conclusions were drawn about the overall patterns of DT use for teaching and learning at the participating schools (Faber et al., 2023).

The qualitative information from the individual in-person interviews that were recorded on audio during the study's data collection phase was transcribed by the researchers. The first phase involved analysing the data to gain a broad understanding of the respondents' perceptions of the variables that appeared to affect DTTPD. This was accomplished by reading the transcripts in entirety and making notes on any mentioned significant words, quotations, comments, or ideas. Important assertions or descriptions of unique experiences or viewpoints were then coded or grouped into units, with each code corresponding to a unique, non-repeating significant statement of equal importance.

For every significant comment, the researchers tried to preserve the original wording and sentence structure. A total of three methods of category nomination were used: deductive coding based on theory, descriptive coding based on the researcher's interpretation of the participants' actual feelings and events, as well as in vivo coding based on the participants' exact words (Calvo & de la Cova, 2023). To maintain consistency throughout the coding process, each code was continuously compared to the earlier codes. The meaning of each important statement (unit) was specified in the third step, which involved formulating meanings. In the fourth step, units or codes containing statements with appropriate material were joined together to produce emergent themes based on the summative constructed meanings (McMillan, 2024). The researchers made a conscious attempt to mitigate any assumptions or preconceptions held over the respondents' perspectives to minimise prejudice during the iterative process of theme building (Ellis & Hart, 2023). Classifying the emergent themes into a priori meta-themes was the last phase. The themes were then debated and presented narratively. The final step involved classifying the emergent themes into priori meta-themes, which were then presented and discussed in a narrative way together with some being verbatim.

The research process for the study complied with all ethical guidelines (Johnson & Christensen, 2024). Involvement was entirely optional, and individuals were free to leave the process whenever they wanted. Additionally, the respondents

were advised that no names would be revealed and that their information would be kept private. Furthermore, there was no discussion of delicate subjects among the respondents, which would have required invasive, intrusive, or maybe dangerous procedures. It was crucial that this study be scholarly in character and that the findings be used to educate all interested stakeholders, including the necessary policymakers, on the DTTPD status quo at the eight schools.

5. Quantitative results

5.1 Respondents' demographic background

Although not all the respondents answered every question, 191 (64%) of the 300 participants that were purposefully chosen to participate returned entire questionnaires. The demographic information was elicited through the first part of the questionnaire. The demographic background is shown in Tables 1, 2, 3, and 4.

Table 1: Gender distribution of teachers

Response item	Frequency	Percentage	Cumulative percentage
Female	143	74.87	74.87
Male	48	25.13	100
Total	191	100	

As indicated in Table 1, 143 (74.87%) female teachers and 48 (25.13%) male teachers participated in this study. Compared to the male respondents, there were 95 more female responses. Given that DT resources and their advantages are accessible to all people regardless of gender, this notable disparity does not necessarily mean that there are no equal possibilities to obtain them. The DoE's 2007 e-education policy makes this apparent by stating that all the teachers must have access to TPD.

The teachers were asked to verify their age groups. Table 2 shows the responses:

Table 2: Distribution of teachers' ages

Response item	Frequency	Percentage	Cumulative percentage
Below 29 years	26	13.62	16.48
Between 30 and 40 years	57	29.84	43.45
Above 40 years	108	56.54	100
Total	191	100	

Table 2 illustrates that 26 (13.62%) of the 191 teachers were below the age of 29 years; 57 (29.84%) were between 30 and 40 years of age; and that 108 (56.54%) were above 40 years of age. This indicates that most of the teacher respondents were above 40 years of age. This is a possible challenge to DT usage as these teachers might be accustomed to the old pedagogy, where teaching and learning entailed talk, chalk, and textbook (Ndomondo, 2024).

The teachers were asked to verify their teaching experience. Table 3 shows the responses:

Table 3: Distribution of teachers' teaching experience

Response item	Frequency	Percentage	Cumulative percentage
Less than 2 years	10	5.24	5.24
2-3 years	5	2.62	7.86
4-5 years	10	5.24	13.1
6-10 years	63	32.98	46.08
More than 10 years	103	53.92	100
Total	191	100	

Table 3 shows that ten (5.24%) of the teacher participants had less than two years teaching experience; five (2.62%) of the teachers had teaching experience of between two and three years; ten (5.24%) had teaching experience of between four and five years; 63 (32.98%) teachers had teaching experience of between six and ten years; and 103 (53.92%) had more than ten years teaching experience. Most teachers had been exposed to teaching without the use of DT resources and relevant TPD; hence the full adoption of these tools might be delayed due to resistance to change (Choi et al., 2020).

The teachers were asked to verify their current post-level. Table 4 shows the responses:

Table 4: Distribution of teachers' current post-level

Response item	Frequency	Percentage	Cumulative percentage
Principal	3	1.59	1.59
Deputy principal	5	2.65	4.24
Head of department	33	17.46	21.70
Teacher	148	78.31	100
Total	189	100	

Table 4 shows that three (1.59%) of the 189 respondents who responded to this question were principals; five (2.65%) were deputy principals; 33 (17.46%) were head of departments; and most of them which is 148 (78.31%) were post-level 1 teachers who are hands-on with what goes on in the classroom daily. To obtain a comprehensive understanding of the DTPD and DT integration statuses at these schools, it was imperative that the study's participants be teachers at different post levels.

5.2 Quantitative data

The teachers were asked to verify whether they received DTPD. Table 5 shows the responses.

Table 5: Distribution of teachers' access to DTPD

Response item	Frequency	Percentage	Cumulative percentage
Yes, I received DTPD	97	52.43	52.53
No, I did not receive DTPD	88	47.57	100

Table 5 illustrates that 97 (52.43%) of the 185 teachers had access to DTPD, and 88 (47.57%) did not have. According to these comments, there is still work to be done before the full potential of new technologies for teaching and learning is achieved. These results indicate that the DBE still has a long way to go before all its digital initiatives and policies come to fruition.

The teachers were asked to verify the duration of the DTPD that they were offered. Table 6 shows the responses.

Table 6: Distribution of duration of DTTPD facilitation

Response item	Frequency	Percentage	Cumulative percentage
One day to one week	34	21.66	21.66
One week to one month	88	56.05	77.71
Up to a year	25	15.92	93.63
Two to four years	8	5.10	98.73
Other	2	1.27	100
Total	157	100	

Table 6 illustrates that 34 (21.66%) of the 157 teachers had accessed DTTPD for a duration of one day to one week; 88 (56.05%) for one week to one month; 25 (15.92%) for up to a year; eight (5.10%) for up to two years; and two (1.27%) for other periods. The results indicate that most teachers had not accessed effective DTTPD. In other words, training programs that adhere to professional competency development requirements to enhance all the teachers' digital competencies are urgently required to be implemented.

The teachers were asked to verify whether they received pedagogical DTTPD. Table 7 shows the responses.

Table 7: Distribution of pedagogical DTTPD facilitation

Response item	Frequency	Percentage	Cumulative percentage
Yes, I received pedagogical DTTPD	97	54.8	54.8
No, I did not receive pedagogical DTTPD	80	45.2	100

Table 7 illustrates that 97 (54.80%) of the 177 teachers had accessed pedagogical DTTPD, and 80 (45.20%) did not access this type of DTTPD. It is clear from these responses that the teachers did not access adequate pedagogical DTTPD, and this gap requires urgent attention. This view is supported by Fernandes et al. (2020) who elucidate that adequate TPD is required to help the teachers to develop basic digital technology skills, relevant pedagogical understandings, and deeper understandings of content and appropriate enhanced inquiry teaching methods. It suggests that these programmes must be carefully planned and implemented. The teachers were asked to verify whether they would like to receive more pedagogical DTTPD in relation to the subjects that they teach. Table 8 shows the responses.

Table 8: Distribution of teachers' needs on more pedagogical DTTPD facilitation

Response item	Frequency	Percentage	Cumulative percentage
Yes, I would like to receive more pedagogical DTTPD in relation to the subjects that I teach	156	86.67	86.67
No, I would not like to receive any more pedagogical DTTPD in relation to the subjects that I teach	24	13.33	100

Table 8 illustrates that 156 (86.67%) of the 180 teachers still needed more pedagogical DTTPD, and 24 (13.33%) did not. These comments suggest that while numerous stakeholders have worked with the DBE to try several efforts to accomplish the DTTPD goals, the goals have not yet been reached.

The teachers were asked to indicate (from the given options) possible deterrents to the use of DT. Table 9 shows the responses.

Table 9: Distribution of deterrents of digital technology usage

Response item	Frequency	Percentage	Cumulative percentage
Lack of sufficient subject related training	64	28.70	28.70
Lack of sufficient didactical training	54	24.22	52.92
Lack of financial support	54	24.22	77.14
Time constraints	51	22.86	100
Total	223	100	

Table 9 shows that of the 223 multiple-choice responses, 64 (31.71%) cited a lack of adequate subject-related training as a deterrent to the use of digital technology, 54 (24.22%) cited a lack of adequate didactical training and financial support as deterrents, and 51 (22.86%) cited time constraints as a deterrent. The discrepancies that these DBE schools experience are likewise supported by the data.

The respondents were asked to describe and offer potential solutions to the issues that prevent them from utilising DT in the teaching activities in the form of an open-ended inquiry. The answers suggest several solutions to address the following:

Lack of sufficient subject related DTTPD.

- Workshop on how to use technology in preparing and presenting the subject content;
- Introduce one on one training and have afternoon workshops for teachers;

- More detailed workshops plus three to four months training;
- University to improve DT training on subject presentation;
- Offering subject related lessons using DT, having mentors in schools, in-service TPD;
- Provide training with professionals not just using facilitators;
- Training should be arranged for specific subjects not only for generics;
- Train teachers in a cluster who in turn train others in their clusters;
- Training must be consistent as there is a lack of sufficient pedagogical DTPD;
- DBE must offer more workshops that focus on curricula and day to day interactions with learners;
- Stop training teachers on how to use software but focus on how to make them effective in class.

Lack of support to provide relevant DTPD.

- There is a need for more training;
- Continuous funding by Gauteng Department of Education (GDE) is needed;
- DBE must buy DT resources such as laptops for teachers;
- Budget for DTPD every term;
- There is a need for more time;
- Use weekends for training;
- Provide free periods for guidance;
- Avoid weekend workshops.

These results suggest that the teachers face pedagogical challenges when incorporating digital technology into their lessons since they do not have sufficient pedagogical support for doing so. DTPD programs are desperately needed to improve the teachers' pedagogical use of digital technology.

6. Qualitative results

This study intended to explore the teachers' perceptions on several issues pertaining to DTPD and DT use for teaching and learning under these complex circumstances. The analysis of the interview data focused on what the 24 teaching staff members had to say about DTPD and the DT status in the schools. These respondents included teaching staff at all post-levels. The themes that emerged from the responses in the qualitative data were grouped into the following major categories: Teachers' levels of DT proficiency, DT policies and implementation, access to DTPD facilitation, DT integration with teaching and learning, challenges of DT, and suggestions for effective DTPD.

Theme 1: Teachers' levels of DT proficiency.

The teachers were asked to elucidate their levels of DT proficiency. Some of their responses were as follows:

- *I can use DT but not ISB for teaching. I can rate myself 8/10.*
- *I only use my personal cell phone and laptop but not for teaching.*
- *Yes, I do, I am satisfactory because I still need to learn. I don't know how to prepare lessons on ISB.*

- *No, I don't have that experience with teaching and learning. I need to be developed.*
- *Yes, I do 6/10. There is still room improvement.*

Theme 2: DT policies and implementation.

During these interviews some of the teachers' perceptions on the implementation of DT policies at the schools, and some of their responses were as follows:

- *No,... I don't know anything about any policy on DT.*
- *No, we don't have a policy as such but there is someone who coordinates to ensure smooth running and accountability of access to DT during school times.*
- *ICT committee has placed some regulations, not really policy, on accessibility and accountability of laptops, overhead projectors, and tablets.*
- *We are working on it; we just had a meeting on aims and objectives of the intended policy.*

Theme 3: Access to DTPD facilitation.

The teachers were asked to indicate whether they had received some form of DTPD. Some of their responses are indicated below:

- *As far as I know, before the introduction of DT in Grade 12, there was a workshop during the school holidays, however, after that, I never heard of any training, and no one ever came to the school to train or support teachers on the use of DT for teaching and learning.*
- *There was some kind of training for five days; it was inadequate as I still need to be equipped on the use of DT.*
- *Yes, we have, but it was not that effective as it lasted for only three days, it was inadequate. We want an intensive TPD. They were focusing theoretically on how to prepare using ISB without practically being hands-on. Since we stayed for a long time before they installed ISB in Grade 12 classrooms, had forgotten how to use them by the time they were here.*
- *Firstly, we have never received any training. Secondly, we have never received any DT resources. There are no ISB in Grade 12 classrooms. Teachers and learners are still using chalk, talk and textbooks for teaching and learning.*
- *There was some kind of training which still needs to be improved on. It was just for a short time.*
- *Last year (2016), training was offered but support from DBE is still needed. Teachers from old school wouldn't have grasped all the DT skills in that short time of training. We still need an intensive TPD.*
- *We received some kind of training which was not adequate.*
- *They have workshops/training going on, but I am not sure if teachers attend, though I have attended one of these sessions. Facilitators sometimes come to observe and assist teachers on the use of DT for different subjects.*

Theme 4: DT integration with teaching and learning.

The teachers were requested to give their views on DT integration with teaching and learning. The following were the responses:

- *Tools are not being used, no cell phones for learners are allowed in class, computer laboratories not used, classrooms not well structured for DT usage in teaching and learning.*
- *Yes, only Grade 12 classes use DT, the rest is still using chalkboard and text books.*
- *Minimally used by some teachers.*
- *I think younger teachers are, but the older teachers are refusing to move away from old way of teaching because they are not well equipped.*
- *Not all of us since some of the subjects are excluded, for example, Sepedi, Setswana and other African languages do not have writing tools on the ISB.*
- *Not all 11 official languages are taken care of by the DT initiatives.*

Theme 5: Challenges of DT.

The teachers were asked to elucidate on the challenges encountered in DT use for teaching and learning. The respondents indicated the following as the major challenges:

- *Facilities supplied are limited, only three classes access DT yet we have 30 classes.*
- *Process of rolling out DT is gradual, only Grade 12 classes accesses these resources. We are not yet there.*
- *We are a no school fee paying school, we rely on DBE to roll out DT and it has been more than two years waiting for them to roll out DT for Grade 11 classes. Only Grade 12 classes have DT.*
- *Government is not taking responsibility to equitably roll out DT to schools, hence our lack of resources. We also do not have adequate DT infrastructure.*
- *The roll out of DT is the MEC's initiative; however, it is too slow.*
- *The government has a long way to go; only Grade 12 classes have DT access.*
- *We are waiting for DBE to install.*
- *We don't have DT in our classrooms since we only can wait for DBE to roll out.*

Theme 6: Suggestions for effective DTTPD.

The teachers were asked to explain what they recommended on DTTPD for their DT skills to be improved. Below are some of the views:

- *More training and follow-up still required, there are a lot of things we still cannot access.*
- *All teachers should receive TPD since DT is here to stay; TPD that was offered was not enough.*
- *More time is required. They must not train too many teachers at once in a single session. We need to be hands-on with DT for TPD to be effective.*
- *I believe monitored after school DTTPD programmes at an equipped venue (maybe twice in a term); should improve our skills.*
- *In the curricula for teachers, they should introduce DT, the two are currently divorced; they should be linked. They must also train us at school but not during school hours.*

- *Yes, I think TPD should have started with all necessary support to encourage teachers with incentives, to go into institutions to actually study; not have it imposed. Incentives should encourage teachers to run for enrolment. Being sponsored motivates teachers; if you have a willing horse, the job will be done well. It should be done systematically, and not haphazardly. Our educational systems are not in order.*
- *We need more than 1 day in a month which we received for TPD. It was not good enough. We also need DT in our classrooms if we have to improve on our DT skills.*
- *DBE chooses a certain group per term for DTTPD; I don't know what their criteria are. This leaves a lot of teachers unequipped. They should actually send a DT specialist to develop all teachers at the school.*

This study also explored the DT facilitators' perceptions on several issues pertaining to DTTPD and DT use for teaching and learning at the Tshwane south District 4 (TS D4) schools. The analysis of the interview data focused on what one of the facilitators had to say about DTTPD and DT status in their school. The responses in this interview were grouped into the following major categories: Impact of DT on education; facilitation of DTTPD; implementation of DBE DT policies; current DT utilisation strategies; DT infrastructure in schools; and DT facilitators' roles in DTTPD.

Category 1: Impact of DT on education.

The DT facilitator was asked to give views on the impact of DT and how this is highlighted in education, the response is noted below:

There is no way we cannot integrate DT with teaching and learning. Besides being part of global village changes, we have to keep up the pace with the rest; otherwise, we will be left behind. Youth of today are brought up with technology; our traditional methods of teaching have to be changed. The children of today are ahead of us as they are competent users of social media, computers and all other DT resources. When integrated with teaching and learning activities, DT makes everything so easily accessible. The visual impact in 3D form, sound, colour etc. in videos makes everything so real. It opens up a new world; learners get motivated as the learners are enticed by what they see.

Category 2: Facilitation of DTTPD.

The facilitator was asked to share views on the strategies that are in place at the TS D4. The following is what they had to say:

Training can never be always sufficient. However, teachers are overburdened with administrative work. For example, we had training workshops during working hours and teachers did not pitch up as they were at work. We also had workshops after teaching time, former model C schools were busy with sporting activities, hence did not attend. There are time constraints. Distances to travel to attend DTTPD are very expensive for teachers as we cover schools from Mamelodi to Hartbeespoort. This is yet another constraint, financially. Teachers are practically fed up with time and financial constraints on DTTPD. We also tried cascading, that is training some teachers who should in turn train others. This doesn't work as they don't get time to train others. However, various initiatives have been put in place; these include DTTPD workshops by the Teacher

Development Unit in this district; Vodacom and Mathew Goniwe. The latter actually deployed DT consultants to schools whose duties are to ensure teachers get help on DT skills. Not all teachers formally accessed DTPD. We usually invite teachers who are already DT literate to equip them with DT pedagogical skills. However, we would like to have everyone trained; but again, we fail to do that due to financial and time constraints. We are only three DT officials, yet there are over 31 out of more than 240 schools with DT resources; hence training all is almost impossible.

Category 3: Implementation of DBE digital technology policies.

The DT facilitator was asked to explain the extent to which DT policies were being implemented at the eight schools. The following was the given explanation:

There are many policies in relation to DT integration in education. The first one is the White paper on e-Education. We have trained schools and issued them with CDs and physical documents. It's however, unfortunate that some schools did not adopt their DT policies from this document. The second one is the Guidelines for ICT. A lot of training on how to develop policies, e-readiness and e-maturity was done. However, policies and documents are in place, but effective implementation and monitoring is still required.

Category 4: Current DT utilisation strategies.

The facilitator was asked to verify the DT utilisation strategies that were in place, and the following was the given explanation:

There are various strategies that are in place but let me say we are not anywhere near where we want to be; although we are improving from time to time. First, all learners in Grades 12 have tablets which have been loaded with e-books and other educational software. Software on various subjects is being gradually loaded on ISBs. If teachers are properly trained, (note that little knowledge is dangerous), then DT should improve pedagogy.

Category 5: DT infrastructure in schools.

The facilitator was asked to give detail on the current DT infrastructure at the eight schools. The following is what was given in response:

Teachers have laptops and ISBs in their classrooms, and learners have tablets, which are conducive to learning (only for teaching and learning in grade 12 classes). However, due to financial constraints, we cannot meet all the schools' needs on infrastructure. The budget is split among many aspects of education of which DT is one of them. We have donors who can aid the individual school's needs, but this is only possible if the schools take that initiative. Examples include Vodacom and BMW who have done a great job in donating various forms of infrastructure to some schools. However, schools also experience poor connectivity as the access to free Wi-Fi is limited.

Category 6: Facilitators' roles in digital technology TPD.

The facilitator was asked to explain what their roles were to ensure that having DT tools alone without pedagogical and relevant TPD programs at the public secondary schools was avoided. The following was the given response:

We are three DT officials in this unit. I am one the two facilitators and the other personnel is a coordinator. In the ideal world, I shouldn't be sitting in the office, capturing information all the time; but should be at the schools developing teachers on how to use DT tools for teaching. But for more than 25 years of experience, I have been more of an office clerk, sitting in the office, nagging teachers...I want this...send me that! I don't get time to physically get to help teachers improve their skills on DT use for teaching. I would love to but at the moment I cannot. Office work is overwhelming. Sometimes we get to a school for DT monitoring only to find the school generally not in order. I am not blind to that; I have to put certain environmental issues in order for the sake of the children's safety. In that case, I end up not selling the idea of DT to teachers.

7. Discussion of the results

The results show that rather than attending pedagogical TPD on integrating DT into teaching and learning activities, the teachers attended workshops on DT literacy. The results make it abundantly evident that if the desired DT skills are to be realised, the current TPD procedures must yet be enhanced to be useful for teaching and learning. The teachers are still not receiving enough DTTPD, even after the district implemented multiple DTTPD programs. The respondents exhibited a great deal of enthusiasm and readiness to include DT into the teaching and learning environments in substitution of outdated pedagogy; yet they are disheartened by the numerous obstacles encountered in the educational institutions. The absence of ongoing, high-quality TPD support to ensure that the learners receive top-notch education is one of the issues impeding the successful use of DT in teaching and learning. If education stays the same, merely introducing DT resources to schools will not provide high-quality results. Teachers, who are the change agents, are able to effectively provide excellent, interactive, and outcome-based instruction that is flexible and sensitive to the evolving requirements of the learners, the nation, and the global community. Initiatives pertaining to technology must be systemic to succeed. For DT-TPD to be systemic, it must assist the teachers in the efforts to immediately apply new knowledge to teaching. The teachers are not significantly impacted by one-time seminars that have little follow-up or direct relation to the classroom. Therefore, to improve the use of digital technology for teaching and learning, the researchers will introduce and discuss the suggested model for the TPD in the next section of this article.

8. Proposed model

Since technology cannot improve learner or school academic achievement on its own, relevant pedagogical transformation is required (Haßler et al., 2021). In this context, the researchers felt that it was crucial to base this investigation on the five principles of the learning and activity theory (Engeström & Sannino, 2021). These authors give a detailed explanation of the theoretical foundations of the EL and AT in an interview with Ploettner and Tresserras Casals (2016). In this interview, the authors of the EL and AT claim that *"the basic idea is that human beings are not seen as separate from their everyday involvements in various kinds of activities. So, instead of the individual being the unit of analysis, it is the activity which people are involved in. And this means that it is a unit that includes society and the individual. Activity or activity system is a notion that refers to something that is collective. It brings in the collaborative relations between people and it is oriented at objects. Object understood*

here as something which drives the activity, and which gives it meaning and significance... So, for instance in the activity of teachers the object would be the learning of their students. In that sense the object is something that is evolving, open-ended and historically rooted. Activities are also mediated by their instruments, which includes most signs, sign systems and material tools and also mediated by division of labour and rules. So, it's a complex notion, a systemic notion, which is deeply historical and oriented at objects that human beings need to deal with in order to live their lives....For activity theory the unit of analysis and the foundational unit of transformation is the activity system, the collective, object-oriented, artefact-and-culturally-mediated, activity system....It can be certainly seen as a member of the very broad family of sociocultural approaches, but it's quite clear of its own basic concepts.... You could also think about the learning activity or the school-going activity of all the students and the teaching activity of the teacher as two activity systems which interact and try to find a common ground.... I think the first step typically is that people start thinking of educational practices, educational phenomena in terms of activity systems and start to model and think about who these people are, what is their community, what is their object, what are their instruments, what might be their division of labour and rules and what might be the historically evolving contradictions and tensions in these activity systems.... In other words, starting to look at education as a changing constellation of activities and that there are always possibilities and potentials for even radical transformation....We are seeing increasingly education and schools as activities which are indeed changing and sometimes in ways which we feel we don't quite understand. The fact that all kinds of new digital technologies are entering the schools whether we want them or not, and sometimes when we want them, they are not accepted at all, is just an example, not to speak about all these issues of motivation. So, activity theory, as a second step after starting to look at education as activity systems, should look at it as historically changing and contradictory formations. In other words, to start seeing where the troubles come from and what kind of possibilities they open up. And then the third way to use activity theory in education is to actually intervene and to implement the various types of formative interventions.....in school settings and educational settings and I think that is really the test bench for activity theory, in other words putting it into practice and seeing what happens..." (p. 88-89, 91).

Since the study's findings indicate that these schools are not any closer to successfully implementing DT tools and resources to transform them and meet the educational standards of the 21st century because of several obstacles, the EL and AT (Engeström & Sannino, 2021) was consulted in the design of the proposed DTTPD hexagonal interactivity structured model. The proposed model illustrated in Figure 1 is intended to be used to help all the DBE stakeholders to collaborate to successfully handle the current problems. The suggested model must, however, pass stringent validity and reliability testing.

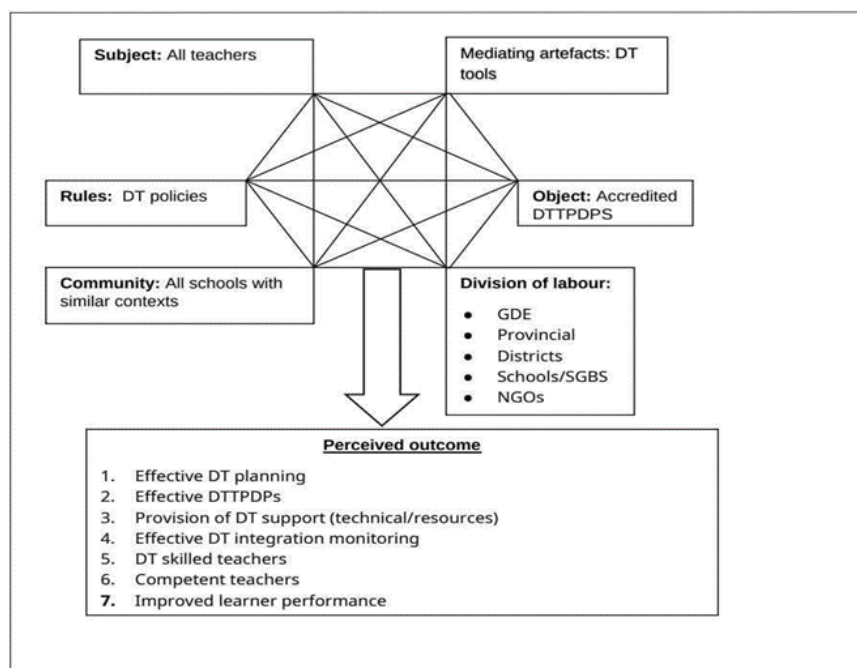


Figure 1: DTPD hexagonal interactivity structured model

As part of an extensive learning process, the current DT practices are questioned, analysed, and then modelled (as this study has done). A pilot study with all the schools that participated in this study is still required to explore and execute a new approach to DTP. Prior to adoption or implementation, the DTPD hexagonal interaction structured model's validity and reliability must be verified after a thorough evaluation of the process. The final stage will involve consolidating and generalising the new method, which still requires in-depth research and is driven by the cycle of expanding learning (Engeström & Sannino, 2010), as shown in Figure 2:

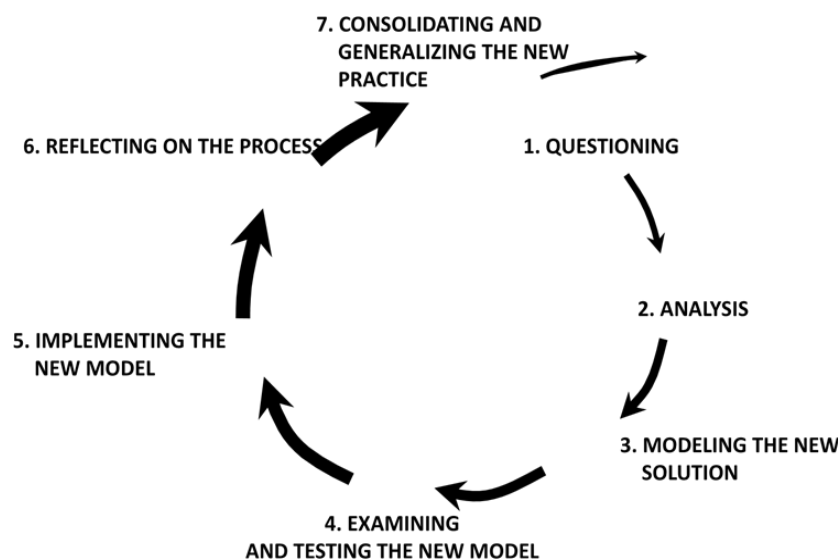


Figure 2: The cycle of expansive learning (Engeström & Sannino, 2010).

It is envisaged that the adoption of this proposed model will influence the realisation of the desired results, if all the stakeholders at all levels of the educational system concurrently engage in the interrelated parts of the DTTPD model that have been described in Figure 4. The analysis of the model's aspects included are as follows:

Subject: The teachers who are supposed to incorporate DT into teaching and learning activities fall under this category. Therefore, in cooperation with other stakeholders who are covered by the division of labour in the suggested model, all the teachers as the findings suggest should immediately access the pertinent DTTPDPs that DBE offers.

Mediating artefacts: In the classroom of the 21st century, all these DT tools are anticipated to be incorporated into the teaching and learning environments. The results demonstrate that not all learners and teachers have access to these vital teaching and learning resources. Every learner should have access to these materials in every classroom. This intervention will improve the teaching and learning processes by expediting the attainment of DBE targets to have teachers and learners who are DT literate.

Rules: The rules in this model imply the DT policies. Although these are purportedly in place, the study's findings indicate that they are not nearly fully implemented due to several problems. Just developing DT policies without ensuring their effective implementation will not change the teachers' pedagogical approaches. According to the suggested model, GDE should work with other stakeholders to oversee the implementation of DT policies at these schools to ensure successful execution.

Object: The proposed model focusses on digital technology teacher professional development programs. The findings confirmed that DTTPDPs have not been effectively accessible to all educators. The development of basic digital technology abilities, relevant pedagogical understandings, deeper topic understandings, and suitable enhanced inquiry teaching methodologies should be required of the DBE. This is because incorporating DT into teaching and learning requires teacher professional development. Additionally, it is recommended that these programs be meticulously designed and implemented. The suggested model suggests that to improve teaching and learning, TPD should be engaging, individualised, continuous, and grounded in content that involves teachers as learners.

Community: All the schools that participated in this study, as well as others with comparable circumstances, are referred to as the community. According to the study's findings, certain schools were entirely excluded from the distribution of DT resources and the associated TPD. To guarantee that no teachers or learners are left behind, they must be provided and accessed fairly. The entire community must have access to pertinent, high-quality TPD for it to be successful. According to this model, GDE should first, in cooperation with other stakeholders, ascertain the needs of all schools and teachers as well as their working conditions, and then give all the assistance they require for successful DT integration with teaching and learning.

Division of labour: According to this model, GDE is responsible for initiating and implementing TPD for the integration of DT in teaching and learning activities at the schools. The GDE and provincial DT staff oversee ensuring that there is enough staff to facilitate DTTPDPs. According to this model, all schools should adopt and execute DT policies, and all stakeholders should work together in a holistic way to interact with one another. To guarantee that all teachers are successfully utilising DT resources in their teaching practices, there should be a commensurate representation of staff members responsible for the meaningful facilitation, implementation, and monitoring of DTTPDPs.

Perceived outcome: The difficulties in using DT for teaching and learning in education that were identified in the results of this study led to the creation of the hexagonal inter-acting structural model. If the current DT policies are to be effective, the researchers agree that it is critical that DT be adopted and used in the school curriculum. Considering this, the researchers suggest using the model in question if the following anticipated results are to be achieved: 1. All the teachers must receive effective DTTPD planning; 2. All the teachers must receive effective in-service DTTPD; 3. Adequate pedagogical DTTPD is provided; 4. Effective DT technical support is provided; 5. Adequate DT resources are provided; and 6. Effective monitoring strategies are developed and put into practice.

9. Conclusions and Recommendations

In the TSD 4 Gauteng Department of Education in South Africa, the study aimed to investigate TPD in the use of DT for teaching and learning at eight public schools. A model to improve the teachers' abilities to integrate DT for teaching and learning activities was proposed after several issues with the district's current DTTPD procedures were found. The proposed model entails the most promising options which include a team-based strategy (division of labour) and continuous training that emphasises practical application for all (community/all schools). Instead of receiving theoretical training without practical support, which will simply lead to a gap between knowledge and implementation in the field, the teachers need to have a thorough awareness of how technology (mediating artefacts) may improve teaching and learning processes. Consequently, the researchers consider that the professional development programs should be more contextualised and adaptable to the ongoing developments in the educational technology institutions. Technology integration solutions should consider the local environment and individual teacher needs in addition to incorporating technical training, pedagogical mindset change, and infrastructure assistance. The teachers must get collaborative, practice-based, and ongoing training to make sure they are equipped to handle the demands of teaching in the digital age. The significance of a thorough and integrated approach to teacher professional development in the digital age is thus highlighted by this conversation. To address the issues found in TSD 4's public schools., this study recommends that 1. GDE must prioritise practical, hands-on teacher training, accelerate resource deployment, and implement robust policies supported by continuous evaluation. By adopting the proposed hexagonal model and fostering collaboration across

stakeholders, South Africa can make significant strides toward achieving effective digital transformation. 2. GDE must set high-quality standards that direct the TPD's design, evaluation, and funding to guarantee efficient DT planning; 3. Prior to the actual deployment of DT for teaching and learning, GDE must make sure that DTTPDs include active learning that involves all teachers directly. During TPD, all the teachers should be actively using the DT materials; 4. The rollout of DT resources, which has already begun but is moving very slowly, needs to be expedited by GDE through fundraising projects and collaboration with various local and international non-governmental organisations (NGOs); 5. To determine which areas of professional development are most needed and deemed essential by the teachers, DBE must regularly undertake DTTPD from school surveys to develop intervention plans. These could be incorporated into the annual quality assurance evaluation processes that are already being implemented by the South African DBE; 6. Since they are thought to encourage them to successfully support teaching and learning using DT in specific schools or districts, GDE may think about offering incentives (accredited certification) when finding and enlisting DT mentors and facilitators; 7. Since it is perceived to have effective potential on altering teaching and learning with DT materials, the researchers recommend that GDE adopts the model as a pilot project, under which the researchers are willing to be part of this exercise that would also serve to validate the reliability of the proposed model.

The adoption of the hexagonal inter-activity model for DTTPD is seen as a possible tool to close long-standing disparities in equity and accessibility to quality education. Thus, teaching and learning can be strengthened and improved, since learning experiences can also be modified to accommodate the needs of all learners through the effective use of digital tools. However, future research should focus on analysing the long-term impacts of integrating technology and pedagogy in professional development programs, particularly in resource-constrained environments. Analysing the effectiveness of technology teacher development models that are tailored to the needs of the teachers across different regions will provide crucial insights on how to close the digital gap. Research could also examine how the frequent exposure to practice-based training programs improves the teachers' skills to integrate technology into teaching and learning activities. Research on how educational policymakers may ensure that all teachers, especially those in public and historically underprivileged schools, have equitable access to digital technologies is also crucial to ensure that no teacher is left behind in the digital era.

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Appendix 1: Questionnaire for school-based staff

SECTION A

Biographical details of respondent

Please use **X** to indicate your response to the question

1) Gender:

Female ☐

Male ☐

2) Age:

Below 29 years old ☐

Between 30 and 40 years old ☐

Above 40 years old ☐

3) Teaching experience

Less than 2 years ☐

2-3 years ☐

4-5 years ☐

6-10 years ☐

More than 10 years ☐

4) When and where did you obtain your highest qualification? (For example: 2007, TUT)? -----

5) Your current post level

a) Principal ☐

b) Deputy principal ☐

c) Head of department ☐

d) Teacher ☐

6) Do you have a personal email address?

Yes ☐

No ☐

SECTION B

The questions in this section pertain to digital technology Teacher Professional Development (TPD). Please answer the questions as honestly as possible.

6. Did you receive training in the use of digital technologies (computers, tablets, laptop ISB)?

a) Yes ☐

b) No ☐

If your answer to question 6 is Yes, answer Question 7.

7. From which type of institution did you receive digital technology TPD?

- a) Officials from DoE ☐
- b) Representatives from Non-Government Organisations (NGO'S) ☐
- c) Educators from a higher education institution ☐
- d) Private training institutions ☐
- e) Other (please specify) ☐

8. What was the duration of the training for computer TPD?

- a) One day to one week ☐
- b) One week to one month ☐
- c) Up to a year ☐
- d) Two to four years ☐
- e) Other, specify

9. Did you receive any training with respect to the teaching of the subjects that you teach to secondary school learners (pedagogical training)?

- a) Yes ☐
- b) No ☐

If you answered Yes to question 9, please answer question 10.

10. For which aspects of your teaching duties in your subject(s) did the digital technology TPD that you received, not cater for?

11. Would you like to receive more subject related digital technology TPD?

a) Yes ☐

b) No ☐

12. In which areas of the content of digital technology related TPD would you like to receive more training on?

13. The following are anticipated problems that deter teachers from using digital technologies in their teaching activities. Please indicate the one(s) that you encounter with an (x) and propose solutions to the problems.

a) Lack of sufficient subject related training for teachers: ☐

Your solution:

b) Lack of sufficient didactical training for teachers: ☐

Your suggestion:

d) Lack of financial support to provide relevant training:

Your suggestion:

Time constraints on the teachers' side: ☐

Your suggestion:

14. Indicate the subject(s) which has/have software that can you confidently use in your teaching activities; and specify the type of didactical development that you have received or still require in the use of that software in your teaching in the spaces provided:

A) Senior Phase: Grades 7-9

i. Home language (specify) _____ ☐

i. _____
 First additional language (specify) _____ ☐

i. _____
 Other subjects:

a) Economics Management and Science ☐

b) Mathematics ☐

c) Natural Sciences ☐

d) Social Science ☐

e) Technology ☐

B) FET Phase: Grades 10-12

i. Home language (specify) _____ ☐

First additional language (specify) _____ ☐

i. Other subjects

a) Accounting ☐

b) Agricultural Management Practices ☐

c) Agricultural Science ☐

d) Agricultural Technology ☐

e) Business Studies ☐

f) Civil Technology ☐

g) Computer Applications Technology ☐

h) Consumer Studies ☐

i) Dance Studies ☐

j) Design Studies ☐

k) Dramatic Arts ☐

l) Economics ☐

m) Electrical Technology ☐

n) Engineering Graphics and Design ☐

o) Geography ☐

p) History ☐

q) Hospitality Studies ☐

r) Information Technology ☐

s) Life Orientation ☐

t) Life Sciences ☐

u) Mathematical Literacy ☐

v) Mathematics ☐

w) Mechanical Technology ☐

x) Music ☐

y) Physical Sciences ☐

z) Religion Studies ☐

aa) Technical Mathematics ☐

bb) Technical Sciences ☐

cc) Technical: Civil Technology ☐

dd) Technical: Electrical Technology ☐

ee) Technical: Mechanical Technology ☐

ff) Tourism ☐

gg) Visual Arts□

Thank you very much for your cooperation!

Appendix 2: Interview questions for school-based teaching staff

1. Do you have experience with the use of digital technologies (ISB, tablets, and computers)? If so, what is your level of proficiency?
2. When and why did your school first start to use digital technologies?
3. Does your school have a policy on digital technologies integration with curricula?
 - a) What does this policy entail?
 - b) Is the policy effectively implemented?
 - c) Do the teachers currently use digital technologies for teaching and learning?
4. In which subjects is teaching and learning enhanced with the use of DT; and how is this feasible?
5. Have any teachers received any professional development in the use of DT for teaching and learning in your school?
6. Who offered this TPD?
7. Describe the process of TPD which has led to the situation that you are at now about your present DT facilities?
8. How effectively do you feel the school is using the DT resources which it has? Give reasons for your answer.
9. If you have been able to successfully integrate DT into the learning and teaching process in the school, what, in your opinion, have been the main reasons (enabling factors)?
10. What has been the most significant benefit to your school arising from the introduction of DT?
11. What, if any, are your concerns about the impact which DT use may have on teaching and learning?
12. How supportive is the governing body towards the use of DT at the school?
13. If DT are only being used for school administration, what have the reasons been for not integrating them into the curriculum?
14. What in your opinion have been the main hindering factors to the provision and use of DT in the school?
15. How do you see the school overcoming these problems in the future?
16. What is your vision for the use of DT in your school in the future?
17. Do you feel that the teachers and learners have benefited from the use of DT in the school?
18. Have you received any form of TPD from any of the following groups in setting up and making effective use of the DT? If so, give reasons.
 - a) Tshwane South D4

- b) Provincial education department
 - c) NGO
 - d) Governing body members
 - e) Other members of the community •
 - f) Other schools
 - g) Other
19. What do you perceive the roles of the district, provincial and national education departments in relation to TPD in the use of DT the schools?
20. What is your overall view about DT TPD in teaching and learning?
21. What suggestions would you make for the effective DT TPD to enhance the integration of this tool in teaching and learning?

Thank you very much for your cooperation!

Appendix 3: Interview questions for TSD 4 DT facilitators

1. Should digital technologies be integrated into teaching and learning?
 - a) If so, how?
 - b) What bearing does this have on the TPD that you offer?
2. Should digital technologies be integrated into the curriculum?
 - a) If so, how?
 - b) What bearing does this have on the TPD that you offer?
3. Do you offer developmental programmes to equip basic digital technologies literacy skills before the pedagogical integration of these tools is attempted?
 - a) If so, how is this done?
4. Do you offer TPD on how to teach subject content using digital technologies?
5. What do you perceive to be the role that digital technologies TPD should play or in education? Why?
6. Elaborate on the GDE's policies on the pedagogical integration of digital technologies? Are teachers aware of these?
 - a) How do you implement them?
7. How effective is the current utilisation strategy for digital technologies? Will it be effective in improving the pedagogical integration of these tools?
 - a) What is your role in implementing this strategy?
8. What possibilities and pedagogical opportunities do digital technologies TPD sessions create?
 - a) Give examples of the type of activities that are offered in those sessions?
9. Are the schools' digital technologies infrastructures conducive to subject content teaching and learning? Why?
10. How should learning using digital technologies take place in these schools?
11. How should teaching take place to ensure this kind of learning?
12. What is the role of the e-learning coordinator in ensuring digital technologies are pedagogically integrated?
13. What knowledge do you need to have to effectively implement TPD programmes?
14. Have you had any training on the pedagogical integration of digital technologies? If yes, elaborate.

thank you very much for your cooperation!