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Strategies to support progressed South African Grade 12 Mathematics learners

Abstract

The introduction of progression policy, which prohibits the repetition of a grade to more than once within each of the four phases of Basic Education, was enforced in South Africa in the Further Education and Training phase in 2013, but appropriate strategies which could be applied to support progressed learners are not addressed.

This research was qualitative by nature and approached according to the interpretative paradigm. It was a comparative case study, which investigated strategies to support Grade 12 progressed Mathematics learners using Information Communication Technologies in comparison with other strategies that do not apply ICT instructional technologies. Data collection strategies were semi-structured interviews, questionnaires and support policies. The study population was sixteen FET Mathematics educators from five schools in Ekurhuleni North district.

The findings indicated that connectivism, when incorporated into teaching and learning, becomes an effective support tool for progressed learners. ICTs within networks makes teaching and learning more learner centred, improves participation, learner attainment and pass rate. Learners are able to learn at their own pace, in their most convenient set-up and they manage what they learn, how they learn, with whom they learn and what information they require. The study found that there are greater benefits of using ICT instructional technologies in a connectivist classroom to support progressed learners, but that traditional support strategies cannot be ruled out due to the socio-economic challenges schools under research experienced. The findings further indicated that there is a dire need of a comprehensive support policies, strategies and guidelines to support progressed and low-ability learners in Mathematics both digitally and non-digitally.

Keywords: connectivism, communication technologies, information, mathematics, progressed learners, traditional support strategies

1. Introduction and background

The South African School Act of 1996, according to the DBE (RSA, 1996) outlines how learners move from one grade to the next. The first is learners who are promoted to the next grade as indicated in CAPS Policy (DBE, 2011). The second is the number of years in the phase and the third is the age of a learner in that grade termed age cohort (DBE, 1996). This means that a learner may not be retained twice in a phase and an over age learner must be condoned to the next grade to be on par with his or her age peers.

This therefore means that even if a learner does not meet promotional requirements, he or she should be progressed to the next grade due to either age cohort or number of years in the phase (DBE, 2011). Both promotion and progression contribute to the development of a learner in a higher grade. In the case of progression, this is in spite of not having achieved the least prerequisites. The progression policy was enforced in 2013.

There are conflicting views with regard to progression policy or social promotion. Defenders of the progression policy contemplate that repetition has social and scholastic expenses and scarcely any drawn-out advantages. These negative impacts incorporate and support the probability of exiting of school before completion and conduct issues, including delinquency (Jimerson, 2001). The monetary expenses of repetition are additionally high (Walton, 2018). Teachers are the main opponents of the progression policy. Zimasa (2016) argues that progression leads to high failure rates at exit grades such as Matric.

2. Rationale

Leithwood and Jantzi (2006) assert that at times, classroom teaching may not be as effective as expected due to the educators' teaching styles. Theories such as behaviourism and cognitivism do not take into account the changes brought into teaching and learning by technology. Connectivism as argued by Siemens (2006) and Downes (2008) is a theory that aims to fill the gap in teaching and learning in the digital world. The reasons for undertaking this study was to collect evidence that describe the different ways in which Grade 12 progressed Mathematics learners are supported.

3. Problem statement

Early in 2020, the South African Department of Basic Education released the country's National Senior Certificate results for the 2019 matric learners. These are referred to as the "matric results" and they determine admission and placement into higher institutions. About 81.3% of those who wrote the matriculation exams passed (DBE, 2020). What was of much concern from these results, is what Minister of Education, Angie Motshekga, said about the drop in performance in Mathematics. This is one of the most important subjects that is considered critical for the country's economic growth and development.

This decline was twofold: there was a decline in the number of learners writing the Mathematics examination from 270 516 in 2018 to 222 034 in 2019 (DBE, 2020). The second determinant was the performance: only 54% of the learners who wrote the exam, passed it. The minimum score for a pass in Mathematics is 30% (DBE, 2017). This then indicates that only 54% of Mathematics examination candidates achieved a mark of at least 30%. Of all the Mathematics candidates only 2% (4 415) obtained distinctions. A distinction is a score of 80%–100%. This is down from 2.5% in 2018.

South Africa is faced with a serious challenge in terms of learner performance, especially in Mathematics, thereby adopting the progression policy, which aims to ensure that learners are at least not stagnant in one grade or phase (Moayyeri, 2015). According to Spaull (2013) and Reddy *et al.* (2015), one of the common reasons cited behind the progression of learners is to minimise the number of learners dropping out, ensuring that they attain at least the National Senior Certificate (DBE, 2015). It is therefore assumed that it is better if a student is progressed and given extra support, thereby creating a chance of completing basic education (DBE, 2017).

This rationale has been challenged by educators, according to Zimasa (2016) and Nomahlubi (2018). Educators are faced with the challenge of teaching a mixed, large classroom of high-ability learners and progressed learners, and it is expected that these learners should be on the same academic level by the completion of the academic year (Sinyosi, 2015).

4. Research questions

Based on the above objectives and rationale of the study, the following questions were formulated.

4.1 Main question

How can ICT and non-ICT instructional technologies be utilised to support progressed Mathematics learners?

4.2 Sub-questions

- What ICT and digital network strategies can educators use to support progressed learners in Grade 12 Mathematics?
- What type of digital networks can assist in supporting progressed Mathematics learners?
- What other strategies exist to support progressed Grade 12 Mathematics learners?
- What are the benefits of using ICT and non-ICT instructional technologies to support progressed learners?
- What are the challenges educators encounter in supporting progressed learners in Mathematics with ICTs and non-ICTs instructional technologies?
- What is the effectiveness of the current support strategies on progressed Mathematics learner performance?

5. Literature review

5.1 Information and communication technologies

ICTs include all technological gadgets utilised to promote teaching and learning. With the rapid global change brought about by technology in the workplace, home and school, the importance of incorporating ICT into teaching and learning is stressed (Ting, Lam & Shroff, 2019). Globally, it has been noted that the increase in the integration of ICT into teaching and learning prepares learners to become global citizens (Shaffer, 2006). Computer integration in teaching and learning can improve the teacher pedagogy and further enhance a learner's ICT interactions in the digital world (Satrya, Daely & Nugroho, 2016).

An advanced digital classroom is a teaching and learning space digitally upgraded, where teachers, learners and technological tools are involved in knowledge formation (Das, 2019). The rationale behind the computerised classroom is not to replace the teacher's role in class, but to make teaching and learning simpler by addressing the requirements of a technologically advanced generation and growing advanced links with the world. ICTs incorporated for educating and learning include a wide scope of computerised instruments utilised in the class (Das, 2019).

5.2 Information and communication technologies in South Africa

Since the inception of the White Paper on e-Education in 2004, the operation Phakisa in 2015 and the 2013–2025 e-Education strategy of the DBE there has been little or no progress in the roll out or use of ICT in the process of teaching and learning in the South African previously disadvantaged schools (Ntsobi, 2022).

Denoon-Stevens and Ramaila (2018) highlight the importance of ICT facilities and their availability in poor communities and this notion is supported by Ismail, Jogazai and Baloch (2020) to achieve the full benefits of ICT in the teaching and learning, Ostrocwick (2018) suggests that the following challenges should be addressed in South African ICT roll-out programs: return on investment, competing priorities, threat on crime, bullying, vandalism, connectivity and loadshedding. According to Graham, Stols and Kapp (2020), it is estimated that only about 26% of South African educators possess minimal basic technology skills, of which only 7% functions at an intermediate level of expertise. The 2019 Action Plan indicates that “there is still a major weakness in the system when it comes to the implementation of ICT to improve the teaching and learning process and ICT enhanced learning has not as yet advanced in South Africa” (DBE, 2014: 14).

The above challenges are concerning factors, as numerous studies echo the benefits of ICT integration into teaching of Mathematics, especially for low-ability learners. Graham *et al*. (2020) postulate that interactive whiteboards have been linked with an increased learner attainment both in English and Mathematics while using within a group design. The findings of Chen and Wu (2020) indicate that when integrating ICT into Mathematics remedial instruction, learners’ attainment was significantly higher in the post-test as compared with when ICT integrated remedial instruction was not implemented. Other studies by Skryabin *et al.* (2015) and Petko, Cantieni and Prasse (2017) indicate a positive link amongst learners who use ICT tools to learn Mathematics and their achievement.

5.3 The world view on mathematics

In recent years, several countries have invested both time and finances to come up with effective interventions to improve Mathematical attainment. The findings of an early study of highest performing countries in Mathematics and Sciences indicated many curriculum changes, such as the decrease in content by 30%, and the introduction of technology into the teaching and learning of Mathematics as a teaching and support mechanism (Kaur & Lee, 2017). These countries place more emphasis on the digital teaching methods in the foundation phase or lower classes. “The importance of having a solid background in Mathematics is well recognised as it serves as a gateway to future professions in a variety of fields worldwide” (Casinillo, 2019: 2).

5.4 South African mathematics performance

The release of the 2015 Trends in International Mathematics and Science Study (TIMSS) reports for Grades 5 and 9 once more provoked another storm of debate as South Africans grapple with the reasons behind the poor performance in Mathematics and Science. This coincides with the Department of Basic Education’s announcement of a 20% Mathematics pass rate due to a large number of pupils who pass all subjects except Mathematics and are subsequently forced to fail the grade as Mathematics is one of the compulsory subjects to pass (Letaba, 2017:1).

It is of further concern to see a small percentage of learners achieving a score higher than 50% in Mathematics since the 2018 NCS examination in every South African province, as indicated in Table 1 below.

Table 1: Candidates' performance in Mathematics by province and level of achievement at 50% and above (DBE, 2021)

Mathematics									
Province	Total Wrote			Total achieved at 50% and above			% achieved at 50% and above		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
North West	9 083	8 783	**9 232**	2 231	1 870	**2 373**	24.6	21.3	**25.7**
Northern Cape	2 798	2 613	**2 708**	613	523	**574**	21.9	20.0	**21.2**
Western Cape	15 418	15 419	**14 322**	6 176	5 693	**5 707**	40.1	36.9	**39.8**
National	**233 858**	**222 034**	**233 315**	**50 701**	**45 090**	**52 073**	**21.7**	**20.3**	**22.3**

Mathematics									
Province	Total Wrote			Total achieved at 50% and above			% achieved at 50% and above		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
Eastern Cape	36 449	35 270	**38 717**	4 948	4 354	**5 272**	13.6	12.3	**13.6**
Free State	9 722	9 886	**11 040**	2 792	2 597	**2 778**	28.7	26.3	**25.0**
Gauteng	35 279	35 412	**37 680**	11 635	10 542	**11 510**	33.0	29.8	**30.5**
KwaZulu-Natal	61 686	57 882	**56 506**	10 850	9 540	**11 539**	17.6	16.5	**20.4**
Limpopo	39 216	34 148	**38 447**	7 006	5 886	**7 233**	17.9	17.2	**18.8**
Mpumalanga	24 207	22 621	**24 663**	4 450	4 085	**5 087**	18.4	18.1	**20.6**

Looking at Table 1 above, there is no province that has produced at least 50% in Mathematics for the past three years. The highest in the last three years is the Western Cape where at least 39-40% of their learners achieved above 50% in Mathematics. The province with the lowest number of learners attaining above 50% for the last three years is the Eastern Cape with an average of 13%.

5.5 Progression policy

The Department of Basic Education (DBE) characterises progression as "… the movement of a student to the next grade, regardless of the student not having consented to all the advancement prerequisites" (DBE, 2013: xi). This strategy was first used in connection with the General Education and Training (GET) phase (Grades R–9), and in 2013 a guideline was accepted which took into consideration progression in the Further Education and Training (FET) phase (Grades 10–12). Regarding guidelines identifying with the National Curriculum Statement Grade R–12, pitched on 28 December 2012, a student may fail once in a phase and should be moved to the next grade to try not to spend more years in that phase (DBE, 2017).

In enhancing and guiding the implementation of progression policy (DBE, 2015) schools are mandated to give these learners extra support and monitor their progress throughout the FET phase. Mogale and Modipane (2021) indicate that this policy was blamed for the decline in Grade 12 results in 2015 and as a result there is a dire need for schools to come up with support strategies to assist these learners to improve their performance. Grossen, Grobler and Lacante (2017) maintain that progressed learners cannot cope and hence fail Grade 12, thereby making progression more of a challenge than a solution. “This policy was aimed by the Department of Basic Education to give learners a chance to succeed and to complete the basic education cycle.” (Makhanya, 2021: 9)

5.6 Theoretical framework: Connectivism theory

The theory that is utilised and examined is the connectivism theory. This is a theory proposed by Siemens (2005) and Downes (2012). This study has applied the connectivism theory because it strives to comprehend learning as a process of linking specialised nodes, networks and sources of information. Siemens (2005) asserts that at times, learning in this theory is through non-human appliances. Connectivism theory is a learning theory introduced with the view that knowledge can be derived from any source; not solely from a single individual (Mechlova & Malcik, 2012).

The principle focal point of the connectivism theory as illustrated in Figure 1 below is to comprehend the compelling method of learning through cooperation and collaboration between nodes in a digital world. With the quick increment of web utilisation in both rich and poor countries, knowledge sharing has become more viable.

Figure 1 below shows how connections and networks function in the connectivism learning environment and a teacher and a learner become part of the network.

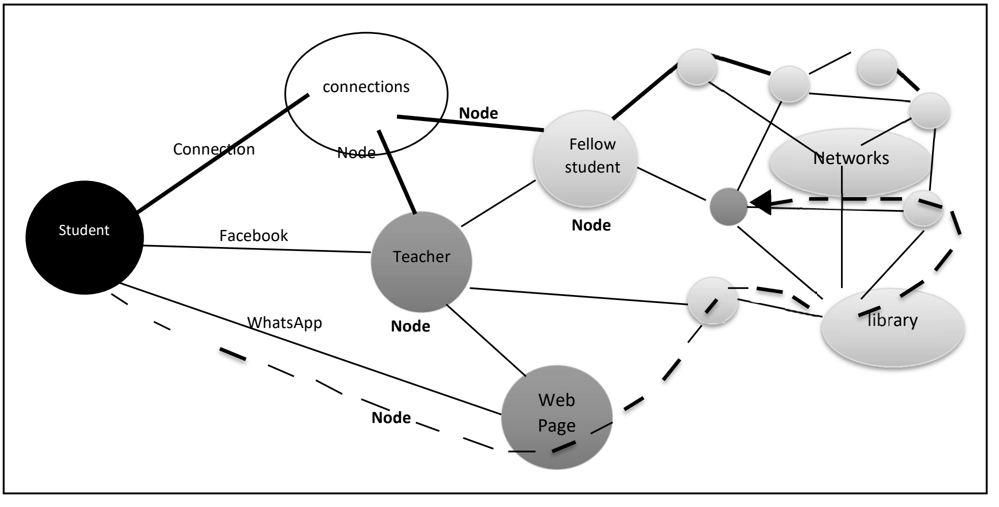

Figure 1: Connectivism Model (Downes, 2019)

Features of connectivism as described by Siemens (2005) and Downes (2008, cited in Boitshwarelo, 2011):

- The main idea in this theory is that learners connect to a community of learning; they acquire knowledge while they also contribute to knowledge.
- This learning group is regarded as a node that forms part of a learner network. These networks are self-created, managed and controlled and the tempo of learning is also managed by a learner through the educator’s guidance.
- Knowledge does not reside in a single individual but is shared among networks and it grows as it is transported from one source to the next.

6. Research design and methods

This study was a comparative case study, which examined and synthesised the connections, contrasts, and patterns that exist between two or more examples that have a common emphasis or purpose. In view of the nature of its research, data were collected using qualitative data collection methods. De Vos (2002: 36) states:

> Qualitative research refers to inductive, holistic, emic, subjective and process-oriented methods used to understand, interpret, describe and develop a theory on a phenomenon or setting. It is a systematic, subjective approach used to describe life experiences and give them meaning.

This research was approached according to the interpretative paradigm, as people interpret their networks, create further learning communities, perceive meaning and understanding as they form their own perspectives about the existence of reality (Vandeyar, 2011).

6.1 Study population and sampling

Sampling refers to a segment of a populace or universe (Etikan, Musa & Alkassim, 2016). Purposive sampling consists of identifying well-informed and proficient individuals who are available and willing to take part (Etikan & Bala, 2017). In purposive sampling, two cohorts of teachers were sampled, with Cohort A being ten Mathematics teachers using ICTs to support progressed Grade 12 Mathematics learners from five Circuit 4 secondary schools in Ekurhuleni North district, while Cohort B was six Mathematics teachers who support progressed learners using other types of strategies. The selection of these participants ensured that the researcher acquired adequate and appropriate information required for this study.

These schools are referred to as Quintile 3 schools, which means they are 100% non-fee-paying schools dependent on government grants and donations from the private sector. Although the government supplies these schools with resources, there is minimal ICT resources, as their allocation of resources is divided between textbooks, e-books and other digital resources. These are schools within the researcher's work area and to attain participants was easy. This therefore means in convenience sampling that those who are available and within the researcher's reach were selected.

6.2 Data collection techniques

In order to acquire data for this study, three methods of data collection were utilised. The first was through semi-structured interviews, the second a questionnaire and the third progression policies used by the Department of Education.

"Interviews were used to generate data which was systematically analysed to search for themes and patterns that illustrate similarities/differences and uncover the meaning of the particular experience" (Cooper, Endacott & Chapman, 2009: 157). A questionnaire is defined as a document containing questions and other types of items designed to solicit information appropriate to analysis (Acharya, 2010).

Data were further collected from the following departmental policies: National Policy Pertaining to the Programme and Promotion Requirements of National Curriculum Statement Grades R to 12, Regulation Pertaining to the National Curriculum Statement Grade R to 12, Circular E 35 of 2015, which outlines criteria for the implementation of progression in Grade

10 to 12, and Circular E22 of 2016, which contains the criteria for the implementation of progression policy and Mathematics, and the 2020 annual teaching plan for Mathematics. These policies offered legal guidelines dictating the procedures to be followed in dealing with progression policy.

6.3 Data analysis

In order to undertake and classify data meaningfully, Atlas.ti software was employed. As indicated by Barry (1998), Atlas.ti codes data and classify it into patterns, draws similarities and creates meanings and explanations to a number of categories. “Atlas.ti offers a myriad of analytical tools that allows the researcher to quantify qualitative information through coding, data query, cross-tabulation, and networked visualisation of project design” (Scales, 2013: 1). Data are then transcribed and organised into codes and themes.

7. Analysis of results

7.1 ICT strategies used to support progressed learners

7.1.1 Type of ICT tools used to support progressed learners in Cohort A schools

All participants in Cohort A echoed the same view that their learners use affordable laptops, tablets and interactive white boards as ICT tools that have been procured for utilisation in school through government funding. These devices are linked to the government Thutong website, which gives them access to all their relevant curriculum materials, notes, past question papers and memoranda for revision.

All ten participants shared a common view that they have further allowed cell phone usage at their school as another way to support teaching and learning with different strict usage regulations. These technological tools are not only used in the classroom for research purposes, but they also extend beyond the classroom, forming what Siemens (2006) depicts as connectivism networks.

7.1.2 Types of digital networks created by both individual learners and educators

In responding to how educators go about using connectivism in integrating ICT into their lessons to support progressed learners in Mathematics, all participants indicated that there are digital platforms they have introduced which assist them to give learners expanded opportunities and support activities to study. The most common networks that participants in the study use are WhatsApp, Microsoft Teams, Facebook, Zoom, Shareit and Telegram.

Participant C indicated,

> *With the challenge we are facing of Covid-19, we have created small meeting platforms which translate into working groups whereby we use Microsoft Teams or Zoom to hold class discussions.*

Participant J stated,

> *For most of our interactions we have further created WhatsApp groups and Facebook platforms where information is easily shared.*

Participant A added,

> *With the lockdown, our digital communication improved as we created a number of communication platforms such as Share it, WhatsApp, Zoom and Facebook at our school.*

Although the participants shared common networks that they use to support progressed learners, WhatsApp and Facebook are the most popular, followed by Shareit Telegram and Zoom, with Microsoft Teams less popular.

7.1.3 The benefits of using ICTs in connectivism networks to support progressed learners in Mathematics

The following analysis was stated as perceived benefits of using connectivism and ICT to support progressed learners. All participants shared the following views:

- ICT supported lessons are simpler and easy to administer.
- Various methods are uploaded and shared among the learners that make teaching and learning easier, especially with low-ability learners.
- Learners then have a choice to follow their preferred method of solving any mathematical problem other than where they are forced to use one method that an educator prefers.
- Lessons are more learner-centred and discussions are broader in these digital learning groups.
- Learners have the responsibility to learn from one another, share ideas and research for better available solutions to various problems. "*This encourages peer learning,"* echoes Participant A.
- It encourages student engagement not only amongst the learners and the educators but also with the applications and resources they find online.
- ICT and connectivism enhance continuous learning beyond the classroom and teachers mostly use it for homework purposes.
- It allows revision and cross-reference by learners and learning becomes continuous.

ICTs in the digital era have further changed the educational atmosphere in numerous forms, which include the teaching setting and teaching resources employed in the classroom (Floris, 2014). This notion is shared by Participants F, A and C, that learners are able to learn in the comfort of their homes and are able to choose their networks which may consist of people and websites they are comfortable to learn from.

All participants shared Van Niekerk's (2009) view that ICT within a connectivism ideology has also offered room for personal growth. It opens doors and access to knowledge beyond the classroom. Participant D indicated,

> *Learners get instant feedback from each other.*

It also promotes deep learning and enables teachers to respond to learners of different abilities (Lau & Sim, 2008).

Mustola *et al.* (2018), share this view with participants that learners are excited about navigating the digital fantasy world while learning and sharing their new knowledge. All ten participants shared the same view that the creation of networks has enhanced communication among learners enabling peer to peer education (Downes, 2019).

7.1.4 Learners' reaction towards learning with ICTs and connectivism

All participants agreed that remote learning offers learners adaptability not usually possible in the class setting. Online learning permits learners to move from static learning materials to more dynamic, engaging and interactive media content, according to the majority of participants. Eight of the ten participants agreed that at the beginning, these networks were not as effective as learners used this platform for more social contact than studying. However, the school closure due to Covid-19 lockdown created a sense of need to learn through these platforms. Learners seemed to depend on using these platforms to ask for clarity and share solutions. Participants further agreed that these networks are less intimidating than a traditional classroom where shy learners are unable to express themselves; a view echoed by Downes (2012) that social networks open free discourse.

7.1.5 Challenges of teaching progressed learners using ICTs

- Lack of resources, poor usage of existing resources, connectivity and loadshedding

  All the participants echoed similar views that they have to use what is available at their schools in terms of ICT resources, however they have not received any formal training or reskilling, making them unable to explore the full potential of ICT incorporation into the teaching of Mathematics. Other similar views were poor connectivity, lack of resources and loadshedding both at school and at home to allow connections to function effectively.

- Compact annual teaching plans

  One of the biggest challenges cited by all participants was the heavy workload of the annual teaching plan for the Grade 12 learners, which needs to be covered prior to examination and offer extra support at the same time.

- Absenteeism

  There were conflicting views on the issue of learner absenteeism. Of the ten interviewed three participants (B, E and J) indicated that some learners prefer to learn remotely especially during the Covid-19 pandemic, and this has reduced school attendance by some learners and another discovery was that educator absenteeism increased as well.

- Lack of interest and monitoring

  All the participants indicated that not all learners are part of these social networks due to poor monitoring, while other learners do not have any interest in the online learning platforms.

7.2 Non-ICT support strategies used to support progressed learners

7.2.1 Extra lessons for reinforcement and revision

From the six participants that did not use ICT strategies, the most preferred time for extra lessons for progressed learners. Extra lessons are conducted before school, in the afternoon or on Saturdays. Most learners prefer to attend extra lessons before school.

7.2.2 Content gaps and critical areas

The second strategy as indicated by participants is to concentrate on Level 1 and 2 questions and re-emphasises basic Mathematics skills. One common assertion was to give weekly practice tests and revise solutions using separate support or intervention books. These findings were common among all participants.

7.2.3 SSIP classes

SSIP is a School Support Intervention Programme funded by the Gauteng Department of Education, which offers learners an opportunity to attend Saturday support sessions and different tutors, or teachers are appointed to facilitate the teaching and learning. The participants have indicated to be a part of this programme and use this opportunity to address challenging concepts on a face-to-face lesson and have ample time to address different groups of learners according to their academic needs.

7.2.4 The significance of the support strategies used by the participants

According to all participants, extra lessons or classes that are more focused on progressed learners assist them to grasp concepts better than in a normal classroom setting where learners are mixed, and the pace may be quicker. Secondly, all participants shared a common view that giving these learners individualised support enables them to understand concepts better and they communicate better in smaller groups than in a bigger classroom with other learners.

7.2.5 The benefits of the applied support strategies

The following list indicates common views of observable benefits of supporting progressed learners as reiterated by the six selected participants:

- Learner performance improves (at least 30%).
- Learners are exposed to the questioning styles through drilling of past question papers.
- Concepts addressed in a smaller group are better understood.
- It enhances learner technique of handling questions.
- It reinforces Mathematics basic skills.

7.2.6 Challenges of supporting progressed learners

As much as educators indicated that there are benefits of supporting progressed learners, they also experience challenges in their intervention processes, namely:

- Poor participation or attendance of extra lessons.
- Lack of commitment by some learners.
- Lack of parental support or involvement.
- Late coming to some of the extra lessons.
- Lack of resources in the schools.

7.2.7 Progressed learners' results analysis and performance tracking

Figure 2 below indicates the progressed learner's performance for Terms 1-3 and the preliminary examination. According to this figure, not much progress was achieved, especially at the end of the year with preliminary exams.

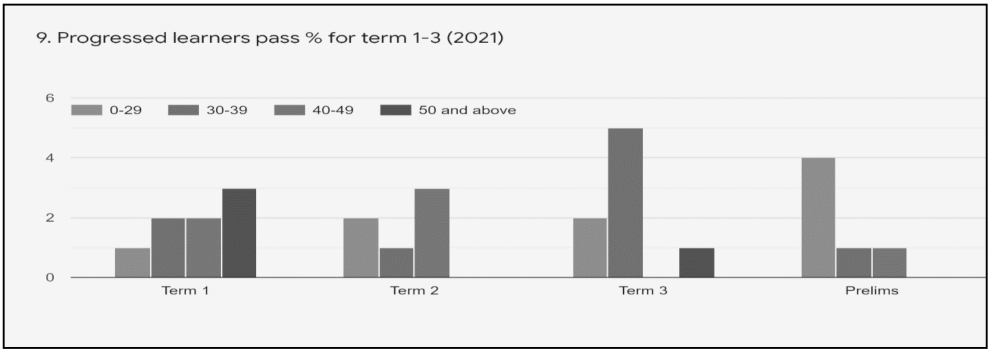

Figure 2: Progressed learners' performance for Terms 1-3 (2021) and preliminary examination

Looking at the results above, participants indicated that progressed learners decrease or lower their overall learner pass rate and contribute negatively to their general performance.

7.3 Comparative analysis of findings

7.3.1 Support strategies used

All sixteen participants agreed that there is a knowledge gap and poor knowledge of general Mathematics basics, which constitute at least a 30% pass mark. The general argument from the participants is that concentrating on filling this gap will contribute positively to Mathematics attainment, but what differed were strategies employed by these two groups of teachers (Cohort A and B). Teachers who were interviewed advocated the use of digital networks to disseminate information, while the teachers who participated in the questionnaire believed face-to-face on smaller-group classroom engagements are their way of filling the content gap.

All teachers from both cohorts believe that Mathematics learning is a continuing process, which extends beyond the traditional classroom in which learners grow a deeper comprehension of correct Mathematical concepts and processes. This common agreement then saw the use of extra classes as reiterated by six teachers and digital online networks as argued by ten interviewed teachers as some of the strategies that could be developed to enhance and improve the process of learning Mathematics.

The support strategies employed by these two cohorts (A and B) are influenced to a large extent by the behaviourist, constructivist and connectivist theories. The six participants who participated in the questionnaire believed in reinforcement of concepts through drill and practice, which is a behaviourist school of thought (Reimann, 2018), compared to the ten educators who were interviewed who strongly believed in knowledge creation and discovery learning (constructivism as explained by Mattar (2018), and collaborative learning through digital networks (connectivism), as outlined by Siemens (2006).

7.3.2 Impact of support strategies used

Looking at both results from both Cohorts A and B, one can describe that Cohort A (who use both the traditional classroom and digital technological instructions) have observed a positive impact compared to the Cohort B teachers who experienced a decline in learners' performance.

The Cohort A teachers reiterated the use of concrete and digital manipulatives as teaching aids. This is in contrast with Cohort B teachers who preferred worksheets, past question papers and exemplars. The benefits of teaching Mathematics from concrete to abstract have been noted. As learning becomes practical (Kumar & Kumara, 2018), it allows for a differentiated Mathematics approach (Valiande & Tamara, 2011) and learning through discovery enhances practical basic Mathematical skills (Yadav, Gupta & Khetrapal, 2018).

7.3.3 Challenges of support strategies

Looking at the level of participation, both teachers in Cohort A and B share a common view that not all learners under intervention programmes do actually participate. Poor attendance, lack of commitment or interest, lack of resources (attending camps or Saturday lessons, or internet connectivity) were mentioned as barriers to the successful participation in the intervention programmes. Lack of resources or underutilisation of existing resources, connectivity and loadshedding were also highlighted as major obstacles in supporting learners.

What differed between the participants was the flexibility offered by networks that a learner can find information at his or her own time and may be able to catch up, unlike in the face-to-face support sessions where a learner may not be able to understand concepts if he or she has missed a lesson.

7.4 Support strategies post-Covid-19

This study was conducted during Covid-19, the time each school had to come up with ways to enhance teaching and learning beyond the face-to-face classroom set-up. The ten participants using ICTs interviewed earlier indicated that their schools have improved their ICT resources over the last two years as the benefits were very visible. Participants A and B indicated that all their Grade 12 classes have now been installed with interactive white boards, a tool which allows teaching to become more interactive and brings abstract objects to life. Participants D and H have indicated that they introduced Google classroom as their teaching practices improved with time. A common view all ten participants shared was that there is a shift in policy within their schools towards the incorporation of ICT into teaching both at school and beyond the school as a support tool for learners. It has now been formalised compared to how it began in 2020 as an informal individual strategy. Another interesting view shared commonly by participants is that supporting learners became easier now that learners are available physically and digitally, meaning it has improved learner access.

7.5 Document analysis

7.5.1 Policy review

The following policies provide a guideline on how learners should be moved from one grade to the next. The National Policy Pertaining to the Promotion Requirements of the National Curriculum Requirements for Grade10–12 (2016), as depicted from Notice No R1114 in *Regulation Gazette* No 9886 of December 2012, outlines a detailed criterion for moving learners in Grade R to 12. As outlined in this policy, a learner can only repeat once in this phase so as not to spend more than four years in the phase. This policy specifies that if a learner has to repeat a grade for the second time, he or she must be moved to the next grade and schools have been instructed to offer such learners extra support in the grade. This process is termed progression.

7.5.2 Circular E 35 of 2015 and Circular E 22 of 2016 (DBE, 2015; DBE, 2016)

These criteria were set to ensure that learners meet certain minimal, basic requirements to cope in the next grade.

- The learner, according to the two circulars, must have failed and repeated at least Grade 10 or 11 in the FET phase.
- To progress the learner, he or she must at least have passed the school's language of teaching and learning and at least three of the seven subjects offered.
- His or her school attendance must also be on a regular basis. If a learner is absent for more than 20 days without a valid reason, such a learner may not be considered for progression.
- For a learner to further qualify for progression, he or she must have complied with school-based assessment requirements.

The two circulars further state that progressed Grade 12 learners may choose the multiple examination opportunity option (MOE). This indicates that they may decide not to write all six subjects in the November exams.

8. Study limitations

The findings of this study cannot be generalised as representing a broader population of South African schools using connectivism in ICT. This study was a research project in fulfilment of a PhD dissertation. Its main objective was to investigate the use of connectivism as a support strategy for progressed learners in Mathematics using ICT.

The sample for this study was only sixteen Grade 12 teachers teaching Mathematics in Circuit 4 Ekurhuleni North district. This then implies that the sample was not a full representation of what exists in all Gauteng schools, especially as the education classification is very different and the resource allocation is not the same.

9. Contribution of this study

This study contributed as a source of knowledge and a point of reference for future scholars. The study has further contributed to the literature, especially in South Africa where the progression policy is still in its inception stage. Connectivism theory has never been used in the literature on progression theory; this makes this study very useful in terms of its contribution to the literature. Moreover, because the country has not yet developed a blueprint of support strategies for progressed learners, this study will act as a reference for the Department of Education in the roll-out of support strategies to support many progressed learners, especially in Grade 12, using ICTs and guided by connectivism ideology.

10. Recommendation for future research

The application of connectivism has been echoed as impactful both through literature and participation in South Africa and globally, although the scale of application is still low. It is recommended that this study will be explored further in the South African context, as progression policy does influence the South African education system. A broader sample of both urban and rural schools still needs to be explored, and this study has the potential to be a comparative case study, where a researcher is involved in testing two classrooms using traditional teaching methods and connectivism theory used in ICT. There is also a further need to do this study using the foundation phase and track their performance over a couple of years using different subjects in different grades. Most importantly, there is a dire need to create support policies, strategies and frameworks to support progressed learners.

11. Conclusions

Recently digital network learning adaption as a pedagogy has become quite popular even among researchers. This has been absorbed to enhance a number of learning methods like cooperative and network learning. Despite this new interest, only a few studies have recommended a full integration of connectivism as a theory for learning to be applied as a strategy to support progressed learners (Greenhow & Galvin, 2020; Manca, 2020). In the South African schooling context where progression is fairly new and under robust debate, the implementation of this policy and support strategies recommended have been deemed problematic (Mogale & Modipane, 2021). There is a concern pertaining to the progression policy affecting learner pass rate (Nomahlubi, 2018, Zimasa, 2016).

As much as progression policy is highly defended and advocated for various reasons (DBE, 2021), this study has a new focus by comparing both the traditional support strategies and digital support strategies, which answers some of the challenges posed by this policy. The main reason the researcher undertook this study was that there has been no study that has focused on the use of connectivism specifically aimed at supporting progressed Mathematics learners, especially in township schools, using ICT.

One could then conclude that looking at both sets of data, traditional support strategies like extra lessons have produced quite limited results in comparison to the digital network support strategies, but that traditional support strategies cannot be ruled out due to the socio-economic challenges schools under research experienced. The findings further indicated that there is a dire need of comprehensive support policies, strategies and guidelines to support progressed and low--ability learners in Mathematics both digitally and non-digitally.

Ethics statement

This research was approved by the ethics board of the University of Pretoria on 23 July 2021.

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