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THE INFLUENCE AND VALUE OF SCIENCE AND TECHNOLOGY IN THE EDUCATION SYSTEMS OF SOUTH AFRICA AND RUSSIA

ABSTRACT

The aim of this study was to identify the influence of technology on the education systems of South Africa and Russia. The study has brought to light the importance of technology, and that it contributes to the increase of quality of education. The correct application of relevant technology in education can be used as valuable support to education delivery, it can stimulate creativity, contribute to the development of higher-order cognitive thinking skills, assist learners to develop technological skills and finally it can help economic growth in the country. Moreover, the study created an opportunity to highlight differences and similarities in the purpose of technology, the access to and distribution thereof, the implementation thereof in classrooms and the challenges in terms of implementing them successfully. By using a comparative method, the researchers had the opportunity to identify gaps in the research for future studies, methods for the implementation of technology and universal challenges, such as the digital divide. This study has provided ample evidence of the value that technology adds if successfully implemented and how much value it can bring towards an education system. This is also the reason why an education system of any country should ensure the sustainability of the implementation of technology in the system. It is important that the education systems of both South Africa and Russia proceed to directly identify and address gaps in their approaches to implementing technology. It is also important for these countries to release more relevant data and policies regarding this topic, specifically in education. Although the role of the BRICS organisation is identified as the science and technology innovation (STI) initiative, there are no clear indicators in policy documents or references to technology in education. Moreover, looking specifically at the BRICS countries, it is clear that they have made strides in addressing such challenges as stipulated in the literature. To conclude, this research can be used to further address the challenges and limitations that were identified in the study in order to assess the future impact of technology on an education system.

Keywords: *Technology; education systems; South Africa; Russia; science and technology; BRICS.*

1. INTRODUCTION

The level of success of an education system can be found at the level to which it succeeds to provide in the real and ever-changing education needs of its target group. The education system should provide the learners sufficient opportunities, on pre-primary, primary, secondary and tertiary education levels, to prepare themselves to live their roles in life successfully. These roles include for example their roles as family members, citizens and career persons. The ever-changing education needs of the learners from the target group are influenced by the ever-changing lifeworld of learners in which they should function. One of these continuous changes is the aspect of science and technology that (should) have a direct influence on the content of the curriculum and on the nature of teaching (Steyn & Wolhuter, 2014).

The changes in the field of science and technology is clearly demonstrated by the sequence of industrial revolutions, from the first industrial revolution, during the second half of the 18th century to the most recent fourth industrial revolution (iED Team, 2019). The characteristic of the fourth industrial revolution can be explained as the integration and connectedness of different technologies such as artificial intelligence, biotechnology and nanomaterials. A paradigm created around the fourth industrial revolution is based on the fact that what we now know as it presently is, will not exist in the future (Penprase, 2018: 215; Schwab, 2018). Also, what we know as the industry – factories, liberties and so forth – will cease to exist. The source of the fourth industrial revolution and its impact on education and society are still unknown, but the urgency for schools to prepare and adopt a technological environment cannot be stressed enough (Penprase, 2018: 217; Ndung'u & Signé, 2020). The focus is placed on science, technology, engineering and mathematics (STEM) education, which should develop a capacity for improvement and the incorporation of artificial intelligence, data science, robotics and so forth, so that basic understanding and knowledge can be fostered among the future generations (Scepanovič, 2019; Butler-Adam. 2018). To understand the influence of these remarkable changes in science and technology on education and the education system are of major importance to provide quality education and will be one focus of this article.

To understand the influence of science and industry on particular education systems, it would be very informative to use the education systems of BRICS as example. "BRICS" is an acronym for a cluster of nations that consists of five countries with imperiously growing economies (Kolachi & Shah, 2013), namely Brazil, Russia, India, China and South Africa. The BRICS-organisation is a major role player in the international scene and represent at least 23,3% of the global gross domestic product (GDP) (Schwarzman, Pinheiro & Pillay, 2015). "BRICS" was formed in 2010 when South Africa joined the previous BRIC-organisation (Kolachi & Shah, 2013). It is generally accepted that the BRICS countries are "becoming the hub for natural resources, hydrocarbon reserves, production, consumption, technology and forward-looking opportunities while also being equal contributors to human capital" (Kolachi & Shah, 2013: 105) with the consequence that the use of science and technology will play a major role in their economies. Similarly, to liberal arts education, the recognition of science and technology as core factor should be regarded as progressively important in the 21st century to develop a variety of cognitive skills for lifelong learning. Therefore, ensuring the ability to practise relevant competencies (knowledge, skills and values) are essential to cope with the fourth industrial revolution (Lewis, 2018). Thus, the second focus of this article will be the influence of science and technology on the education systems of South Africa and Russia, because a discussion regarding the influence in all countries is too large.

Therefore, the aim of this article is to identify and describe how technology influences the South African and Russian education systems. In countries such as South Africa and Russia (part of the BRICS organisation) that are serious about the development of stronger economies by means of an effective and sustainable education system, the increasing of the use of technology cannot be overemphasised and is non-negotiable. A central focus of the article is a focus on technology and particularly to indicate how the one education system can learn from the other in implementing and bridging the digital divide. It is important to indicate methods by which technology can successfully be implemented to better prepare future generations and add value to the education system in general.

2. PROBLEM STATEMENT

The world is constantly changing, and as it is moving into the fourth industrial revolution, it is shifting to a more technologically inclined orientation (Penprase, 2018). Examples of such technologies that will dominate the years to come, according to Penprase (2018), are artificial intelligence, biotechnologies and nanomaterials. This is where the current research has been born – the urge to understand the influence of such competencies on education and the educational systems of South Africa and Russia and the value it holds. The rising gap in knowledge regarding information and communication technology (ICT) in schools and classrooms raises problems for the preparation of future generations to thrive in the technological era that is to come (Department of Science and Technology, 2019). The problem that guides this study is not only the influence of technology on education in South Africa and Russia but also the value in quality it contributes to the education systems and classrooms of these two countries in bridging the digital divide.

"Technological innovation is considered as being one of the major driving forces in fostering economic growth" (Santana *et al.*, 2015: 425). Moreover, sustainable development, technological innovation and economic growth play a significant role in the development and growth of the BRICS countries (Santana *et al*., 2015). Makarov *et al.* (2011) situate Russia and South Africa, two of the BRICS countries, in a deteriorating trade affected by the economic downturn.

Adding to the abovementioned problem, Chetty *et al.* (2017: 1) highlight that only 40% of the world's population has access to digital technology. Chetty *et al.* (2017: 1) define this digital divide as a form of "exclusion, poverty and inequality … [that] continues to be exacerbated due to the effect of unemployment, and due to poor digital skills". Thus, this research aimed to identify gaps in terms of the influence of technology on education that has not been widely discussed in the literature, while also portraying the value of technology in education systems.

In accordance with the above literature, the following problem statement has been formulated: Technology plays an important role in developing fourth industrial revolution skills among the youth; however, there is a lack of technologies in schools, and the importance of the use thereof is not stressed enough.

3. RESEARCH AIMS

This article reports on research with the aim to explore the use of technology to increase the quality of education in the education systems of South Africa and Russia. The research aimed to:

- identify the influence of technology in the South African and Russian education systems; and

- identify the challenges in the implementation of technology in the education systems of South Africa and Russia.

4. RESEARCH DESIGN

The research methodology used in this study was the qualitative tradition and the nature of the paradigm was interpretivistic. Qualitative research methods were used to gather, interpret and analyse existing theories on the influence of technologies on the educations systems of the two chosen BRICS countries to enhance the understanding of the value that technology contributes to our schools by going through each element of the research design.

For this study, document analysis was the primary data generation method used to gather relevant data. Documents that were used in this research included the following: published and unpublished documents, educational policies, memorandums, letters, reports and articles. The following search engines were used to gather documents for this study namely, Google Scholar, J Store, EBSCOhost, and Research Gate.

The instrument used to understand and explore the impact of the technology on the two education systems, was the theoretical guidelines of the internal and external contextual factors of the education system. According to these guidelines the nature of an education system is also determined by external contextual factors that are linked with the nature of the particular target group. Examples of these are the demography, the economy, language(s) and culture as well as science and technology. The comparative method used in Comparative Education was used to compare the influence of technology on the education systems of South Africa and Russia. Using the comparative perspective helped to identify, understand and evaluate different aspects of the education systems required to improve the respective education systems (see Steyn *et al.,* 2017).

5. LITERATURE REVIEW

The purpose of conducting research into the abovementioned topic was to identify the value that technology has for the BRICS countries, by using Russia and South Africa as typical examples. The aim of the literature review is to discover and learn from previous literature on the state of technology supply and usage in the schools and education systems of these two countries.

In order to fully understand the issues that are being addressed, the following key concepts need to be explained:

5.1 Technology

Technology can be defined as a "science that encompasses the systematic study of the structure and behavior of the physical and natural world through observation and experimentation" (Oxford Reference, 2020), which can then be applied to technology in the development and use of technology. From another perspective technology can be defined as the use of scientific knowledge, skills and values to serve practical purposes, in the everyday life of societies but especially in the environment of commerce and industry. The term particularly refers to those machines and instruments that help man to live with greater ease and comfort (*cf.* Google dictionary, 2021). Furthermore, technology can be defined as an aspect that allows global

access to knowledge, has an impact on global social, economic, and political situations, and allows countries and businesses to develop (Steyn *et al.,* 2017).

Furthermore, technology plays a significant role in people's daily lives through phones, the internet, automobiles, computers and cell towers, to name a few examples. As a result, technology has an impact on every aspect of our lives. Most people's homes have computers, which are used by children and adults to surf the internet, send text messages, use social networks, play games and do a variety of other things (Costley, 2014).

The White Paper on Education and Technology in South Africa states that many challenges have been overcome, but there is still a large gap between schools with adequate technological resources and those that suffer from poverty, with individuals who are technologically illiterate as a result of this situation. South Africa strives to promote lifelong learning, and the use of technology can help to reach this goal (*cf.* Steyn *et al.,* 2017). Furthermore, Steyn *et al.* (2017) state that the availability of relevant technology in schools is scarce due to a lack of knowledge and creativity, high demand, insufficient funds and expensive technology.

5.2 Value of technology

Even in 2004, when discussing technology in education, it was stated in the *White Paper 7* (Department of Education, 2004) that the world was in a process of globalisation, filled with new challenges posed by technology. It was found that technology changed the workplace, how one functioned in the work environment and how information is perceived, the equal distribution of technology as well as the ever-greater role of technology in education (Department of Education, 2004). Cordell *et al.* (2012) pointed out that the use of technology in education assisted with the implementation of the common core standards, improves graduation rates and prepares learners for life beyond secondary education.

Moreover, *White Paper 7* (Department of Education, 2004) explains that an education system has the responsibility to create a means for quality education to be delivered in promoting economic and social growth. Utilising technology in teaching and learning is powerful and provides education options such as replicating the classroom practice or including guest speakers worldwide. It is a fact that technology keeps evolving and that remote education is a new trend that must be pursued by educators because it offers an additional way of teaching and learning Picker (2020). That being said, it is important for developing countries to consider enhancing quality by increasing access to ICT. The correct use of ICT has the capability of addressing many inequalities in education systems to overcome barriers; it is revolutionising curricula and proposes new oppositions to challenge educations systems worldwide. These challenges include taking part in the era of ICT, the effect ICT has on quality education and the inclusion of ICT in teaching and learning programmes (Department of Education, 2004). The inclusion of technology in education leads to a situation where the organisation, models, processes and activities of teaching are changed to a mix of technological digital applications in a prioritised and strategic manner to accommodate the fast-growing changes and needs of a digital society (Gobble, 2018).

5.3 Advantages of technology

Technology plays an important role in people's everyday lives, including the diverse environment of employment that did not previously require technological skills but that have now adopted the use of new technology (Costley, 2014). Technology has improved individual's participation in education because it allows learners to engage in an additional manner with the teachers,

other learners, the content and the relating world (Costley, 2014). Moreover, technology creates alternative learning opportunities that allow learners to learn hands-on (Costley, 2014). It is even argued that the most important aspect of the implementation of technology in education is to provide adequate education that learners can acquire competencies in the use of technology. Some authors even explained that the use of technology in education can be compared to the availability of a teaching assistant, not only to support the learners but also to, for example, assist teachers to find solutions to education-related problems (Kapur, 2019). The advantages of the use of technology in education is listed by Kapur (2019) and are provided in Table 1.

Table 1: Advantages of science and technology in education (adapted from Kapur, 2019:3)

Advantages	Description
Communication	Communication forms an integral part of people's daily lives. It can be conducted in a socially formal or informal way. It is made more accessible through technologies such as computers, smartphones and laptops by sending email correspondence worldwide.
Research	Research forms an important part of education, especially in higher educational institutions. It can be conducted through books and articles, as well as e-books and internet searches.
Increase motivation	It has been found that when technology is incorporated in the learning experience and when technology aids the teaching experience, learners are more motivated to participate.
Creativity	Technology allows for more alternative ways in which lessons can be taught and more ways in which learners can complete tasks. An example of this is that when learners have to write an essay, they can make a video or add pictures to aid in their project.

It is generally accepted that technology enables groups to be more creative in approaching education and particularly regarding teaching and learning in new ways. It also supports teachers and learners in the creation of new real-life opportunities to prepare the next generation to function in the new technological era. According to Savvidis (2016), learners are enticed by the concept of technology and reveal the benefits of using technology in classrooms, such as improving engagement, knowledge retention, encouraging individual learning and encouraging collaboration among learners.

5.4 Challenges of technology

Although technology has already to some extent been incorporated in education, there are still major challenges that prevent this change from being fully implemented. Some of the challenges in terms of the implementation of technology in education, are as follows (Nagel, 2013: 1–2; McLaughlin, 2021):

• Professional development

There is an ongoing lack of professional development to assist teachers in using technology in the teaching and learning process. Due to the lack of professional development of teachers, they are unprepared and unable to use technology.

• Resistance to change

Teachers and school leaders are often scared of change. They may view the use of technology as not being a part of their job description.

•   Delivering informal learning

Many teachers can perhaps be described as professionals that are very rigid and keep to formal ways of teaching in the so called "bricks and mortar" environment. With this attitude they often fail to acknowledge the new manners of relating to the learners. They can be reluctant to work outside the formal structures of teaching and learning.

5.5 Digital divide

Gudmundsdottir (2010: 84) defines the digital divide as "the mismatch in access and use of ICT". There are many gaps in the education system of South Africa, and one of these involves the access to and use of ICT (Gudmundsdottir, 2010). A more current definition of the digital divide is the one by Lexico (2020) describing it as "the gulf between those who have ready access to computers and the internet, and those who do not". *White Paper 7* (Department of Education, 2004) states that the digital divide highlights disparities between richer and poorer communities. Bridging the digital divide does not only have to do with connectivity but also focuses on the following (Department of Education, 2004: 9; OECD, 2021):

•   Collective knowledge generation, learning should be central because machines and equipment are useless without the competencies to use them.

•   Building a quality knowledge basis for the promotion of the economy and online affairs for users' businesses and other sectors in the economy.

•   Developing the capacity of the workforce by improving access to the internet and educational contributions in schools and colleges, creating digital libraries for universities, promoting professional training institutes and stimulating the economy to employ people with a variety of ICT skills.

The focus of bridging the digital divide means that the digital divide and the endeavour to bridge it, aim to meet challenges, not only in education but in the workplace as well, to offer internet access to all in order to offer a wider range of information. ICT can be described as a key component in economic growth and social development. Technology and ICT navigate access to worldwide information and knowledge, but there is an irregular distribution of this knowledge, and it differs between communities and between societies. Due to this irregular distribution, there is a difference between the number of individuals that can use such technologies and those who cannot, which influences economic growth. The digital divide does not necessarily mean that one's access is limited to the technical infrastructure of science and technology; it can also be a gap in terms of social infrastructure (Srinuan & Bohlin, 2011; Solomon & Van Klyton, 2020).

Social infrastructure can be described as a determinant of the digital divide that has ties to demographic elements such as income, gender, race, education, age and location (Srinuan & Bohlin, 2011). Table 2 provides a summary of the different determinants of the digital divide.

Table 2: Elements that determine the digital divide (Srinuan & Bohlin, 2011: 9)

Determinant	Explained
Skills and experience	Having poor skills in ICT will create a gap to cope with new challenges. This means that individuals who did not receive training to be technologically literate will widen the digital divide.
Geography	Individuals living in a rural area where access to the internet is not provided may create a gap regarding new challenges. Working-class societies will most likely have computers and WiFi, whereas a rural or urban community may not have this luxury.
Education	People with a higher degree of education or people from a more formal educational background that was well resourced will most probably have a better background in the use of science and technology than those who had been educated at under-resourced schools.
Age	Older people are more cut off to new changes and the participation with technology than younger people.
Cost	Due to the high cost of technology, the use of technology is limited to the poor. Consequently, lower costs for technology will increase the use thereof by all.
Occupation	More occupations are moving towards the integrated use of ICT. For example, technicians and scientists are more prone to use science and technology in their occupation.

It is important to note that although ICT and science and technology are linked with the digital divide, they are a driving force that facilitates education. The value of science and technology is used to cover the gap that the digital divide creates. Technology and ICT should be understood, integrated and distributed in education, because the use of science and technology builds a foundation for life after school.

6. DATA ANALYSIS: TECHNOLOGY AS AN EXTERNAL DETERMINANT IN EDUCATIONS SYSTEMS

6.1. Technology as an external determinant in the South African education system

In the South African education system, technology in education revolves around the diverse distribution of technology in schools (Sarkar, 2012). This diverse distribution of technology in the South African education system deals with academic readiness, diversity and schooling background (Sarkar, 2012). The use of technology in education became important in order to support the use of science and technology that have become critical for economic growth in developing countries such as South Africa (Juan & Visser, 2017).

The challenge in South African schools is to successfully administer and manage the logical use of various types of technology in the diverse settings of the schooling environment. The aim for South African schools, as mentioned in *White Paper 7* (Department of Education, 2004), is to push South Africa into a new era of finding solutions that can adapt to future growth.

Srinuan and Bohlin (2011) provide statistics from 143 articles, which, when analysed in terms of the digital divide, reveal that Africa, including South Africa, has one of the lowest percentages for access to technologies, not only in schools but also in the wider society.

According to Balancing Act (2020), only 7 000 South African schools have access to the internet, while as many as 21 000 schools still fall short in this regard. Balancing Act (2020) adds that the South African curriculum writers must be advised on how to reach these unconnected schools in order to ensure that learners are equipped with the relevant competencies to meet the needs of the country and the working environment. In addition to the foregoing, Nokwali, Mammen, and Maphosa (2015) state that for technology to be functional for teaching and learning in a classroom, it must first be accessible.

6.2. Technology as an external determinant in the Russian education system

According to Dmitrieva and Khvantova (2018: 3), there is a "convergence of education and economics of knowledge", which involves the growth of the education system in Russia and basic economics and social development. It was proposed that changes be made regarding different digital aspects of the Russian labour market, education and the general economic market to support this convergence of education and knowledge economy. One of the more important changes is the implementation of computer-aided education (Dmitrieva & Khvantova (2018). In 2015, the Russian president supported a development strategy of the information society in the Russian Federation for the period 2017 to 2030 in an effort to address the inequalities caused by the digital divide (Kushnarenko, 2018). Additionally, Kushnarenko (2018) categorised the digital divide into three levels in terms of the obstacles that most countries are still trying to overcome. The first level dealt with access to technology and the internet; the second level involved the different skill levels in technology and the last level referred to the unequal distribution of the internet and technologies amongst individuals and communities in order for them to obtain opportunities related to the technological era. In a survey in 36 countries, it was found that the main factors that influenced the digital divide in Russia regarding the use of technologies and the internet were the age, health, income and education of individuals, as well as the economy (Kushnarenko, 2018). Furthermore, an inequality is reported in the distribution of and access to education based on social, cultural and geographical groups. This can be related to the equitable distribution and access to technology (World Bank, 2003).

The World Bank (2003) created protocols and strategies for technology to be used to bridge the digital divide. Although Russia has made an effort to adhere to these protocols, there is a lack of equipment in Russia to effectively produce enough material and technology to effectively distribute these to different schools. So, although Russia has made strides in this matter, the provision of these technologies has increased the digital divide between the wealthier and poorer areas (World Bank, 2003). More recent studies showed that in 2018, at an education forum in Moscow, it was brought to light that Russia had invested many resources towards the improvement of the Russian education system, with an emphasis on technology education in order to ensure equality in the access to technologies (Hill, 2020).

7. INFLUENCE OF TECHNOLOGY ON THE EDUCATION SYSTEMS OF SOUTH AFRICA AND RUSSIA – A COMPARISON

From a comparison between the South African education system and the Russian education system, it has been brought to the fore that the two education systems have differences and similarities. The following information will highlight the more explicit similarities and differences.

7.1 Similarities of technology in the education systems of South Africa and Russia

The following explicit similarities in terms of the use of technology in the two education systems have can be identified (*cf.* sections 6.1 & 6.2):

- Both education systems aim to implement technology in education to enforce open access to education, which creates opportunities to learn from a distance (Filippova, 2015).

- Technology is implemented in schools to provide a larger scale of educational opportunities and to improve the teaching and learning experience. Technology provides the opportunity to teach a larger mass of learners or to provide access to education on a larger platform to large groups of learners.

- In both countries, there is a clear difference in the socioeconomic backgrounds of learners that divide them, which directly influences the distribution of technology and finances available to access technology.

- Russia and South Africa want to contribute and build towards the economy through the implementation of technology in order to create quality teaching and learning for learners to become a part of society and contribute to it.

- Although South Africa has accomplished much with regard to connecting schools to technology platforms, there are still many individuals who are unprepared when they enter higher education institutions and that do not have sufficient access to technology or the necessary technological skills to help with teaching and learning (Ng'ambi *et al.,* 2016). This can be directly related to Russia as well.

7.2 Differences of technology in the education systems of South Africa and Russia

The following differences in terms of technology in the two systems have been determined (*cf.* sections 6.1 & 6.2):

- South Africa struggled to provide sufficient access to technology due to poverty that is experienced in large parts of the country. The lack of funding in some schools, low levels of household wealth and even crime can play a role in this matter of low technological access. Russia, on the other hand, struggled with access to and the distribution of technology because of a lack of national funding and the unavailability of equipment to distribute the relevant educational technologies (Sarkar, 2012).

- Sarkar (2012) highlights that diversity in South Africa has a direct effect on science and technology in education, culture, language and academic readiness, which is not the case in Russia.

- Russia has made big advancements through changes in its education distribution. However, online learning and technology innovation are still underfunded compared to the rest of the formal education in Russia (HSE University, 2020). In South Africa the biggest focus is still on developing education on all levels, which limited the significant introduction on technology in education.

8. INVESTMENT FROM THE BRICS ORGANISATION IN TECHNOLOGY

Cassiolato and Lastres (2011) mention that the BRICS countries are strongly influenced by historical aspects. Excluding Russia and China, colonialism plays an important role in the current technology proficiency of the BRICS countries. Kuklina (2020) points out that the

science, technology and innovation (STI) initiative of the BRICS organisation has evolved in the past five years, and the Russian Federation is at the forefront of the STI initiative of the BRICS countries. The BRICS STI initiative is based on the four pillars of STI innovation and cooperation in the BRICS countries. These pillars are as follows (Kuklina, 2020):

- Research collaboration with STI workgroups on the enhancement of biotechnology and ICT, as well as preventing and monitoring natural disasters

- Research infrastructure

- Collaboration

- Sustainability

Kahn (2015) explains that various factors influence education and technology in the BRICS countries. The BRICS nations have been utilising the Western higher education model for the past century (Kahn, 2015). In addition to the above, the BRICS countries did not adequately adapt to the industrial revolutions until much later than most other countries, and only then were they able to benefit from new technologies (Kahn, 2015). Also, the BRICS organisation regularly issues strategies regarding STI, with Russia, South Africa and China being pioneers in adapting science and technology innovation (Kahn, 2015).

9. FINDINGS

This research was conducted to generate information regarding technology in education and to analyse the implementation of applicable technology on the education systems of South Africa and Russia. The research aims guided the research and the findings are directed to answer the main research question. By using the aims of the research to guide the study, a literature review was conducted, whereby data collection took place regarding relevant literature analysis. The data were analysed and interpreted in order to arrive at reliable findings and recommendations.

9.1 Technology has been introduced in the South African and Russian education systems

This section deals with the influence of technology in the education systems of South Africa and Russia, which is the main research aim of the study. The study highlighted the general value and acknowledgement of science and technology in education and schools in general. Also, the implementation of technologies in the South African education system and schools as well as those of Russia were described. South African policy documents point out the existence of a digital divide in the South African society as well as in the South African education system, with Russia experiencing the same problem. With the notion of economic growth that is a major aim of the BRICS-organisation, it is important to note that South Africa and Russia ascribe great value to the implementation of science and technology in education to add to and increase economic growth.

Furthermore, a literature review has been conducted, which has revealed statistics in South Africa showing that there is a low percentage of schools that have access to computers and even fewer schools have access to science and technology for teaching and learning. It has been ascertained that the digital divide in South Africa is largely influenced by factors such as different levels of academic readiness, the existence of diversity in different areas and difference in schooling background by the learners.

In addition to the findings discussed above, one of the most important findings is that there is a digital divide in both South Africa and Russia in terms of equal distribution of technology and access to technology. More importantly, it has been discovered that wealth and socioeconomic status have a significant impact on household access to technology and the internet. It has been explained that in Russia the economy and the age, health, income, and education of technology users were some of the main factors that played a role in Russia's digital divide. Another important finding relates to the fact that both Russia and South Africa want to use technology to create alternative and better learning opportunities to reach a bigger target group in need of education.

9.2 Challenges faced when implementing technology

In this section, the way the second research aim, namely, to identify the challenges in the implementation of technology in the education systems of South Africa and Russia, was reached is being discussed. The following can be identified as main challenges that the two education systems faced in terms of the implementation of science and technology in the respective education systems.

The first challenge that both these education systems are facing is the existence of the digital divide. As previously mentioned, the digital divide is defined as "the gulf between those who have ready access to computers and the internet, and those who do not" (Lexico, 2020).

Challenges experienced in South Africa:

- One of the most challenging factors in South Africa regarding the equal distribution of technology is diversity (Sukanta (2012). Diversity can be defined as a multitude of individual differences and similarities that exist among communities, people and organisations (Washington, 2008), which include, for example, race, age, nationality, religion, educational qualifications and economic sustainability. This can be seen as a challenge because South Africa is a large and a very diverse nation.

- Sukanta (2012) adds that this diversity may influence the academic readiness of individuals, and that language and educational background can play a role in creating stronger barriers. This is seen as a challenge because more employment opportunities require employees to have basic technological and computer skills. Moreover, insufficient access to technology in schools will result in a disadvantage when entering the workplace.

- Another major challenge that South Africa is facing in implementing technology in education involves the effectiveness, cost, equity and sustainability of technology provision (Sukanta, 2012). Furthermore, the lack of availability of resources may lead to new forms of exclusion (Cloete, 2017).

- Perhaps the biggest challenge is to motivate education leaders and managers, teachers and learners to creatively embrace the possibilities of introducing technology in education and qualify themselves to introduce it successfully.

Challenges experienced in Russia:

- According to the World Bank (2003), Russia is facing challenges due to a lack of materials and a lack of equipment to produce technologies. This directly influences the ability of the country to effectively distribute technology to different schools. Russia has only recently invested major resources in the endeavour to improve its education system. According to the World Bank (2003), Russia has limited resources to invest in and distribute technology in its education system.

- A real challenges is to ensure an equal spread of technology use in education, where, for example only a third of universities use e-learning on a regular basis (Almazova *et al.,* 2020).

- Another challenge is to increase the ability and readiness of teaching personnel and learners to use technology in education and to transform the curricula to fit the requirements of technology in education (Almazova *et al.,* 2020).

10. CONCLUSION

It is gratifying to observe that South African and Russia are putting a lot of effort into the implementation of technology in their respective education systems. However, there is still much room for expansion regarding the effective and meaningful implementation of technology in the everyday use of this external determinant of the respective education systems. In both countries, the importance of this external determinant is not underestimated, as these two BRICS member states emphasise the impact of technology on not only the development of their respective education systems but also the economic development of the two countries. Both countries emphasise that technology make a valuable contribution to the development of learners and can substantially and positively affect the unemployment of the population. Furthermore, both countries believe that the literacy status of the population of a country is also determined by the knowledge of technology.

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