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Effects of Demographic Factors on Grade-12 Mathematics Learners' Receptiveness to Siyavula Educational Application

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Abstract
This empirical study deploys a partial least squares structural equation modelling (PLS-SEM) to investigate the effects of Demographic factors such as gender, location and usage duration on Grade-12 mathematics learners' receptiveness to Siyavula Educational Application (SEA), a learning managements system (LMS) for basic schools in South Africa. The sample comprises 272 Learners chosen from six randomly selected schools out of a total of 52 high schools were actively using SEA in uMhlathuze circuit of King Cetshwayo District. Three of the sample schools are located in urban areas while the other three are located in rural areas. The study extended the Technology Acceptance Model (TAM) by conceptualizing perceived accessibility (PA), perceived social influence (PSI), perceived skill readiness (PSR) and computer self-efficiency (CSE), thereby developing a new integrated model (SEATAM) designed to understand the actual use of SEA in the context of learning mathematics by grade 12 learners. Analysis of the results indicates that three pathways (Attitude Towards Technology effect on Actual Usage, Perceived Social Influence effect on Attitude Towards Technology, and Perceived Usefulness effect on Actual Usage) are affected by gender; two pathways (Attitude Towards Technology effect on Actual Usage, and Perceived Usefulness effect on Actual Usage) are affected by the residential location variable; and that hours spent has no significant effect on learners' receptiveness to SEA. The implications of the findings were discussed with a recommendation for cogent LMS designs that can conveniently help rural students to be academically competitive with their urban counterparts. This study contributes further insights to the field of new technology usage, user acceptance research, LMS receptiveness, and information systems in its development of the SEATAM model.

Keywords: *Learning Management System, Siyavula Educational Application, Perceived Accessibility, Perceived Social Influence, Perceived Skill Readiness, Computer Self-Efficiency*

1. Introduction

1.1. Introduction

The Department of Education (2020) points out that mathematics helps enhance intellectual approaches that underpin logical and fundamental thinking, accuracy problem solving that will, in turn, help decision-making. The emphasis of recent research efforts has been on the creation of scientific knowledge that applications such as *Siyavula* help build, as stipulated in the curriculum assessment policy statement CAPS document (Department of Education, 2010). The use of different devices during the teaching and learning of mathematics is often

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associated with the assumption that such practices will improve the attainment of learning outcomes. If the present generation of learners can easily adapt to any technological device, a skill that can be tapped into for promoting mobile learning to use what they like the most and spend more time in it, surely it can improve their learning (Anyor & Abah, 2014). If such affinity to technology is fostered it can improve performance in the learning of mathematics (Agbo-Egwu *et al.*, 2018).

Regarding the use of mobile learning in rural areas, researchers have proposed and used the high school's acceptance of mobile learning model to check out the factors that predict behavioural intention to use cellular phones for learning (Mutambara & Bayaga, 2020a). Research has generated much new knowledge on the science, technology, engineering and mathematics (STEM) learning based on the technology acceptance model (Abah *et al.*, 2025). Findings reveal that the high school acceptance of mobile learning model can be used to predict why mobile learning is not well grounded in the learners' educational environment in South Africa and yet there is evidence of widespread use of mobile technologies (Mutono & Dagada, 2016).

The integration of technology in teaching and learning is intended to change the world, accommodate the way teachers and learners acquire knowledge and support schools to improve teaching and learning of mathematics (Tishkovskaya & Lancaster, 2012; Iji & Abah, 2018). Umugiraneza *et al.* (2018) conducted a study on how KwaZulu-Natal teachers use, access and integrate technology in teaching and learning of mathematics. Their findings suggested that almost 80% of teachers who used technology in teaching and learning stated that the use of technology does improve learners' understanding of mathematics. Furthermore, these authors indicated that teachers who have access to the internet have higher levels of confidence in teaching mathematics (Umugiraneza *et al.*, 2018). Professional development workshops that were conducted to develop skills of teachers to teach mathematics via technology were seen to improve teachers' skills regarding the use of graphing calculators and other software (Hartsell *et al.*, 2009). Hartsell *et al.* (2009) further noted that the workshops also developed confidence, a positive attitude towards technology and skills in using technology.

On learners' attitudes towards the use of technology, Eyyam and Yaratan (2014) conducted a study to determine such attitudes and see whether the use of technology can improve their academic achievement. These authors found that the learners who participated showed positive attitude towards the use of technology in class, some were not sure of the change and if it was going to help them to become more successful in their classes, because it was their first time being exposed to that type of learning (Eyyam & Yaratan, 2014). Furthermore, they made it clear that the challenge to the use of technology in teaching was the lack of equipment in schools. Also, teachers were not well trained in integrating technology into their teaching. Similar outcomes were reported by Iji *et al.* (2017) and Iji *et al.* (2018) who specifically established a substantial impact of the utilization of cloud services on students' attitude toward mathematics education in the attitudinal component areas of mathematics confidence, affective engagement and behavioural engagement. Educational cloud services adoption results in a strong positive mentality and self-worth among mathematics education students (Iji *et al.*, 2017; Iji *et al.*, 2018).

Relatedly, Mthethwa (2015) assessed learners' cognitive skills using GeoGebra App and to see whether the application helps learners in improving their performance in Euclidean geometry or circle geometry in the uMkhanyakude District. The author reported that learners showed an interest in the use of GeoGebra as a technological tool in the teaching and learning of Euclidean geometry. Additionally, the author stated that technology implementation remains a major problem because of the lack of sufficient technical support (Mthethwa, 2015, p. 68). A study by Kok (2010) investigated the attitude of in-service teachers at the University of Zululand towards technology. The results of the study pointed out that the teachers showed a strong understanding of technology and showed interest in knowing more about technology. The author further stated that teachers showed low level of knowledge and understanding about technologies used in their daily lives. However, the study also showed that when talking about technology the teachers solely thought of computers, although it is a much broader concept.

Sabyr (2020) also conducted a survey to investigate what learners think about the new approach to learning and how it affects their academic performance. The study found that using technology was interesting to the learner and changed their attitude towards mathematics. The learners stated that mathematics was difficult to learn but, after the introduction of technology, they found mathematics easier to understand (Sabyr, 2020). This significance is not lost to the South African Department of Education (2020) who aims to ensure that children acquire and apply knowledge and skills in a way that is meaningful to their own lives.

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SchoolNetSA, together with the national DoE, stated that there are still schools operating without computers (SchoolNetSA, 2016). Oke and Fernandes (2020) noted that the fourth Industrial Revolution (4IR) is beyond the use of computers as it has potential to impact the way we teach, learn and engage. However, the education sector in Africa is not fully prepared for the 4IR. A study on the readiness of the educational sector for 4IR shows that technology can facilitate learners' learning experience (Oke & Fernandes, 2020). Efforts such as that of the Siyavula Education Application (SEA) are geared towards upending the narrative around technology readiness.

"*Siyavula*" is a Nguni phrase that means "we are opening", which is core to Siyavula's mission to open up education in South Africa. It means something to the many people who Siyavula aims to reach. Siyavula claimed that every learner and teacher should have access to quality educational resources for long term development. Siyavula has faith in time and research for building technology to facilitate profound learning mathematics and science experiences. Siyavula members are working together in making sure of the good foundation of learning in all South African schools. Siyavula focuses more on mathematics and science education for grades 4 -12, aligning with the South African national curriculum. Siyavula migrated its profitable open educational resources (OER) concept-mapping and textbook to work with other African nations, such as Nigeria (Lambert, 2019).

Siyavula evolved from high school science texts to a project with an open mission, where Siyavula technology company was developed. The company started with a project of free high school science texts in March 2002, by Mark Horner, who graduated at the University of Cape Town (Petrides & Jimes, 2008). A group of students asked Horner to demonstrate, step by step, the textbook (covering grades 10–12) including physics, chemistry, life science and mathematics, and make it free and sharable, so they could share notes with their classmates and teachers. The Free High School Science Texts (FHSST) began publishing OER. OER is an educational resources that includes curriculum mapping, textbook, videos, applications and all other materials designed for teaching and learning (Butcher, 2015).

With the support from the Shuttleworth Foundation, the aim was to make licensed content available for all learners in all grades. This project intention was to build better a knowledgeable society with limitless possibilities. FHSST became Siyavula an educational technology company in 2007. Siyavula educational technology was tasked to develop and improve education (De los Arcos *et al.*, 2016). The government distributed millions of printed textbooks to all learners in South African schools at no cost to schools. Moon and Villet (2016) pointed out that Siyavula's mission is to make everyone have access to all resources and support in learning.

Siyavula was able to transform creating learning resources to learning opportunities in South Africa and developed a digital catalogue of OER, textbooks and other online resources which provide learners with quizzes and feedback (Lambert, 2019). Siyavula partnered with, and was sponsored by, the Sasol Inzalo Foundation to produce textbooks for grades 4 – 6 natural sciences and technology workbooks, and grades 10 – 12 textbooks which was printed in both English and Afrikaans.

The Siyavula Educational Application (SEA) was proposed as a software solution for promoting independent study, and to help Grade 12 learners stay motivated and attain invaluable skills to prepare them for university studies. The South African Department of Basic Education (DOE) supports the use of technology to transform the education system (Department of Education, 2020). Siyavula is an organization with a mission to create and engage, integrate, high quality learning in mathematics and science and helping young minds to master and develop skills for their future needs. Siyavula aims to deliver good standards throughout South Africa, and beyond. Siyavula has developed progressive software programs that permit learners to learn mathematics and science. In the SEA, parents and teachers can also enroll to track learners' work. For parents they need a learner's identity link which is obtained in the application and each learner has a unique identity. The SEA learning management system presently covers grade 8 – 12 mathematics and grades 10–12 physical sciences. If a leaner is registered on the SEA, he or she can work independently and with assistance from others.

SEA is unique in that it is a comprehensive application package, while the extent to which it is experienced positively in and out of the classroom has significant implications for its perceived effectiveness in the advancement of learning. This aspect is insufficiently understood by researchers, educationists and practitioners in South Africa. It is towards this end that this research is conceptualized and, hence, positioned, to generate an understanding of the factors that might affect the receptiveness of the application. This study examines the factors affecting Grade 12 learners' receptiveness in using SEA in the learning of mathematics, with specific emphasis on the demographic's effects of Grade 12

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learners on the receptiveness of SEA in the learning of mathematics.

Chibisa (2021, p. 83) defined demographics as "the collection and analysis of broad characteristics about groups of people and population". In a study conducted by Tshabalala et al. (2019), demographic factors, namely gender, level of study, and age, do not influence pre-service teachers' use of Moodle to enhance learning. In this study, the focus has been on two demographic factors: residential location and gender of Grade 12 learners on SEA. Age was not considered because the age difference of Grade 12 learners is generally too small.

The residential location in this study was included to find out how Grade 12 learners in various locations receive SEA in the learning of mathematics. The study explored two distinct school contexts: rural and urban based school contexts in King Cetshwayo District, uMhlathuze circuit. The question was whether Grade 12 leaners in rural and urban schools, when using the SEA, would study mathematics differently depending on where they are located in relation to one another. A number of studies were conducted to determine the effect of geographical location around the world. Syahruddin *et al.* (2021) examined the role of geographical location in Indonesian sport science students. The study was based on the acceptance of distance learning during COVID-19. However, the result shows a huge difference when it comes to the acceptance of distance learning such as learning behaviour patterns and access to technology was revealed to be different according to different location. Cooper *et al.* (2021) argued that geographical location has positive effect on Google search returns when understating a web-search. Based on the findings of research that was undertaken in 12 different countries, 43 items were identified, and concluded that geographical location has positive influence on Google returns. Similar perspectives were offered by Naakaa *et al.* (2019) who recommended among others that school environmental variables should be taken into consideration in the siting and running of schools in order to enhance the students' performance in Junior Secondary School mathematics.

Another study was conducted by Panizzon (2015) in Australia about the impact of geographical location on student achievement in mathematics, comparing students in rural schools and students in metropolitan schools. He stated that student diversity must be considered in order to ensure greater access to mathematics. However, the result of the study showed that students at metropolitan schools achieve better than students in rural schools. Therefore, there may be effect of geographical location on learners in rural areas and learners in urban locations when it comes to the receptiveness of SEA.

In terms of gender, Tshabalala et al. (2019) conducted a study about the extent to which pre-service teachers use Moodle to enhance learning. They explored the effect of demographic influence which was measured on gender, age and level of the study. They reported that gender has no effect on the relationship between pre-service teachers' use of Moodle to enhance learning. In the view of Iji and Abah (2017), research results have specifically highlighted the fact that female graduates of mathematics education are as proficient as their male counterparts in driving value added services in and beyond the education sub-sector. Based on their findings it was recommended that future work may consider an in-depth investigation of the sensitivity of parameters that may have influenced specific probabilities given in their model (Iji & Abah, 2017). In this study, gender may have no effect when it comes to the receptiveness of SEA.

1.2. Problem Statement

This study addresses the lack of research on the receptiveness and usability of the SEA application among Grade 12 mathematics learners. While previous studies have highlighted the benefits of introducing the application, there is a notable gap in the literature concerning learners' perceptions and ease of use regarding SEA (Lambert, 2019). Understanding the learner experience with the application is crucial, especially in the context of the King Cetshwayo District, where schools face challenges such as poverty, high dropout rates, and overcrowded classrooms. By examining the factors that influence learners' engagement with the application, this research aims to promote its adoption as an alternative to traditional instructional methods, particularly considering the evolving landscape of learning driven by technological advancements.

Furthermore, the COVID-19 pandemic exacerbated the need for effective educational technology, particularly for Grade 12 students who had to prepare for their final exams amid school closures. Although some South African schools use the SEA application, its utility, ease of use, and impact on learner performance remain unassessed. Therefore, this study's significance lies in its contribution to understanding the reception and effectiveness of the Siyavula application, filling a crucial knowledge gap in the quest to enhance mathematics education in South African schools.

Marbán and Mulenga (2019) discussed that integrating technology in teaching and learning will make Mathematics more accessible to learners and develop

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skills and high levels of thinking. This study will develop insights for the creators of SEA, as the results of the study can help make the application more effective for learning. The Department of Education (2020) believes that mathematics helps enhance intellectual approaches that underpin logical and fundamental thinking, accuracy, and hassle fixing, that will in turn in help decision-making. This study will explore the scientific knowledge that applications, such as Siyavula, help build as stipulated in curriculum assessment policy statement (CAPS) document (Department of Education, 2010). Such applications generally envisage that learners will be able to solve problems and come up with meaningful solutions to real life problems using decision making that makes use of critical and creative thinking.

This study will assist the DoE in terms of planning and providing learner support in the use of technology. This study will also help universities in preparing teachers to teach effectively and will assist in identifying gaps in the field of integrating technology in the learning of mathematics. There is ample research done on software applications and their benefits, specifically in the context of mathematical learning. Siyavula remains a unique application that offers features to learners that are not commonly made available on other applications of a similar nature.

The sheer scope of varied types of learning that Siyavula offers and its benefits remain to be explored. This research, therefore, contributes to the existing knowledge in the sense that factors such as 'receptiveness' are explored at the level of the learner which makes this research potentially valuable. An extension of the current awareness with regard to the use of SEA thus contributes to a quantitative improvement in instruction that depends on SEA as an instructional software.

1.3. Research questions

The following research question guided this study.

i. What effect does demographics have on Grade 12 learners' receptiveness of SEA in the learning of mathematics?

1.3. Proposed Conceptual Model

This study sought to investigate factors affecting Grade 12 learners' receptiveness of SEA in the learning of mathematics using the extend TAM. Davis (1989) noted convergence of usefulness and attitude towards the system on a person's behaviour. Davis (1998) suggested that PU and PEOU are the main determinants of users' attitudes towards the application. PEOU refers to individual perception on how easy to use technology and PU is individuals' beliefs on how useful technology is (Davis, 1989).

A study conducted by Šumak et al. (2011) examined the factors that have an impact on students' perceptions about the acceptance and the use of e-learning system (Moodle). The results of the study indicated that PU and PEOU are factors that directly affect students' attitudes toward using Moodle, the study further revealed that PU is the most significant and the strongest determinant of students' attitudes toward using Moodle. That means that students like to use Moodle.

This study used the extended Technology Acceptance Model (TAM) initially developed by Davis (1989), to establish the factors that affect Grade 12 learners' receptiveness to SEA in the context of learning mathematics. The reason for using the extended TAM was to take advantage of the suggestion by Davis that researchers should continue to find other variables that are context related (Davis, 1989). As a result, the study used TAM because it allows the addition of the following content variables: perceived accessibility (PA), perceived social influence (PSI), perceived skill readiness (PSR) and computer self-efficiency (CSE). These constructs are critical in this study. However, this is an original integrated model (SEATAM) designed by the study to understand the actual use of SEA in the context of learning mathematics by grade 12 learners.

The conceptual framework is shown in Figure 1, which has eight construct that are explained thereafter, starting with PA, PSI, PSR, and CSE external factors feeding to original TAM by Davis (1989), followed by the four original TAM factors (PU, PEOU, ATT and AU). Basically, the Technology Acceptance Model (TAM) hypothesized that a user's general attitude toward using a system is a primary factor that determines whether he or she uses it. Attitude towards system usage is dependent on two belief functions, perceived usefulness and perceived ease of use. These two are then directly influenced by alternative systems represented as a set of binary proxy variables (Abah *et al.*, 2025).

This study derived from earlier hypotheses towards each construct already tested by Xulu *et al.* (2024). Furthermore, Venkatesh and Davis (2000), noted that it is necessary to hypothesize the relationship between the model variables in order to assess the impact of external variables on TAM constructs.

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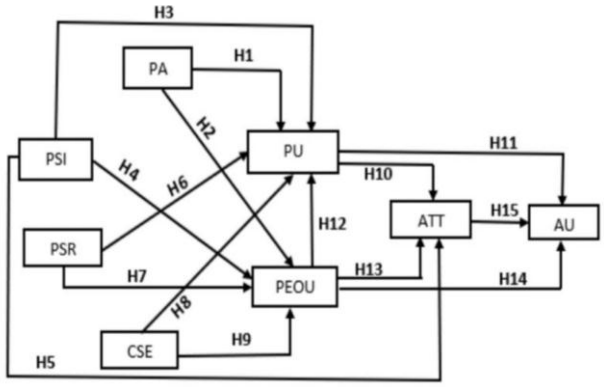

Figure 1: Proposed SEA technology acceptance model (SEATAM)

Perceived Accessibility (PA): Perceived accessibility refers to the degree of how easy a user can access and use the given information system. In this study, PA is how Grade 12 leaners access and use SEA. Past investigations demonstrated that PA has a positive relationship with PU and PEOU (Xulu *et al.*, 2024).

Perceived Social Influence (PSI): Perceived social influence (PSI) refers to how other individuals impact an individual's perception, beliefs, and states of mind towards using the given information system. This implies that Grade 12 learners may consider PSI as an important factor in considering the use of SEA in their learning of mathematics, since their significant other think that they can use SEA in the learning of mathematics (Xulu *et al.*, 2024).

Perceived Skill Readiness (PSR): Perceived skill readiness is one's perception of capability to use a mobile devise, for the achievement of a learning task. In this study, skill readiness implies that most learners have the required technical skills when using any devise for the implementation of SEA. It will be easier for them to engage with SEA than those without the technical skills (Xulu *et al.*, 2024).

Computer Self-Efficacy (CSE): Self-efficacy (SE) alludes to users' capacity and inspiration to perform explicit assignments. Computer self-efficacy (CSE) is centered around the idea of judging one's capacity to utilize an innovation to achieve a specific task or assignment. In computer use, consolation and backing from others, particularly administrators, and gaining from others, can likewise positively influence CSE. With higher CSE, users will have better understanding, invest more energy in computers, and have a more uplifting outlook about it. CSE has a positive effect on PU and PEOU. In this study, if Grade 12 learners are able to use computer technologies, they are more likely to use SEA (Xulu *et al.*, 2024).

Perceived usefulness (PU), Perceived ease of use (PEOU), Attitudes Towards Using (ATT) and Actual Use (AU) are hypothesized accordingly as originally conceptualized by Davis (1989) and Venkatesh and Davis (2000), explained by Abah *et al.* (2025) and tested by Xulu *et al.* (2024). Mutambara and Chibisa (2022) studied the extent to which the following factors explain the actual use of virtual learning (VL) by rural STEM preservice teachers: computer self-efficacy (CSE), perceived enjoyment (PEN), social influence (SI), facilitating conditions (PR), perceived ease of use (PEOU), perceived usefulness (PU) and perceived attitude towards (ATU) ICT. Their explained variable was 74.6% of the actual usage of VL.

Tshabalala *et al.* (2019) reviewed the extent to which pre-service teachers use Moodle to enhance learning; the conceptual model had seven constructs which examined pre-service teachers' use of Moodle: subjective norm (SN), perceived resources (PR), perceived enjoyment (EN), PEOU, PU, attitude towards use (ATT), and actual use (AU). The explained variance of AU of Moodle by preservice teachers was a substantial 69.8%. Based on these results with high explained variances as shown, it means that the identified constructs were the best determinants of actual use of the intended information systems (Tshabalala *et al.*, 2019).

Conclusively, the proposed conceptual model of this study has eight constructs which were examined for their important to the Siyavula Educational Application: PA, PSI, PSR, CSE, PU, PEOU, ATT and AU of SEA. The intention was to find out how far these factors explain the actual usage of SEA in the learning of mathematics.

2. METHOD

2.1. Research Design

This study employed a positivist research paradigm to understand the factors that affect Grade 12 learners' receptiveness of SEA in the context of learning mathematics. The positivist paradigm is associated with the idea of gaining an understanding of human behaviour through observation and reason (Park *et al.*, 2020). Positivism is in line with the current study, where the researcher determined the factors that affect Grade 12 leaners' receptiveness of SEA in the context of learning mathematics at uMhlathuze circuits under King Cetshwayo District.

The study applied a quantitative approach because the focus is to understand the factors that affect Grade 12 learners' receptiveness of SEA in the context of learning mathematics and investigated the role played by Grade 12 learners' demographic characteristics in their receptiveness of SEA.

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This study used a descriptive survey research design, which involves the construction of a set of questions which are either asked by means of a questionnaire or through an interview (Creswell, 2014). Survey design provides a quantitative description of opinions of a population by studying a sample of population. In this study, a survey design was conducted in order to have quantitative description of Grade 12 learners' receptiveness of SEA. A survey was chosen because it has prospects to collect large amounts of data from Grade 12 leaners at uMhlathuze schools. A descriptive, cross-sectional survey design was used to collect quantitative data through questionnaires (Creswell & Creswell, 2017). A questionnaire, in which questions concerning perceived accessibility (PA), perceived social influence (PSI), perceived skills readiness (PSR), computer self-efficacy (CSE), perceived usefulness (PU), perceived ease of use (PEOU), attitudes towards using (ATT) and actual system use (AU) were included, was used along with questions on demographic data.

2.2. Samples/Participants

Learners were chosen from six randomly selected schools in alignment with the methodological conventions found in the literature (Conroy, 2015). A population of 673 learners from the six schools, according to requested statistics from subject advisors, was used for this study. Bhattacherjee (2012), together with Creswell (2011), pointed out that, before sampling the targeted population where the data is to be collected, sampling methods and sampling size need to be considered. The following discussion alludes to sampling methods and sample size of the population.

To collect data, this study adopted stratified random sampling with equal allocation to select participants. To have all Grade 12 learners represented in the survey, a stratified random sampling was used. In this study, and it ensured that each unit in the sample had a chance of being selected to participate in the study (Creswell, 2014). A total of 52 high schools were actively using SEA in uMhlathuze circuit of King Cetshwayo District. Of 52 high schools, of which 41 schools are rural, and 11 schools are urban, the study followed a simple random sampling to select three schools from the rural areas and other three urban schools. This was done to understand the effect of geographical location in using SEA in learning mathematics.

Using simple random sampling, a representative sample of six schools was used for the study, following a recommendation by Conroy (2015), that a representative sample should be at least 10% of the population. To collect data, stratified sampling was used with equal allocation of participants for this study. In all the selected six schools in uMhlathuze circuit that were actively using SEA, each school was used as a stratum. There were six strata altogether, which made a population of 300 learners. Simple random sampling was used to select respondents from each stratum. The 'equal number' strategy of seven-step procedure, suggested by Kumar (2018), as cited by Chibisa (2021, p. 121), was used. The sample size calculation was done by dividing the number of respondents (300) by the number of strata (6), which makes 50 respondents from each stratum. The study used numbered class lists to sample 50 Grade 12 leaners in each stratum. This means that an equal number of learners were selected from each of the selected schools because the goal was not to have proportional representation but to have representation from each school.

Following the recommendation by Hair Jr et al. (2017) as cited by Mutambara and Chibisa (2022), that a sample size should be at least 10 times larger than the number of indicators of the construct with the most indicators, the suggested minimum sample size is 50. For this study, the perceived usefulness (PU), perceived ease of use (PEOU) and perceived social influence (PSI) have the most indicators, of five in each, and therefore data were collected from 300 respondents in this study which exceeded the minimum recommended 50.

2.3. Instruments

In order to collect data that were intended to answer the research questions, the study adapted questionnaires used in similar studies (Mutambara & Chibisa, 2022; Tshabalala et al., 2022). The responses were measured using a five-point Likert scale questionnaire which was self-administered. Data were collected from Grade 12 learners at uMhlathuze circuit schools under king Cetshwayo District in South Africa. A total of 300 questionnaires were administered randomly; 272 questionnaires were returned, giving a response rate of 97%.

A questionnaire is basically a series of questions that is used by a researcher to gather information from respondents. The responses were measured using a five-point Likert scale, ranging from 1 – strongly disagree to 5 – strongly agree, with the mid-point (3) representing the state of being uncertain or neutral. The questionnaire was designed to collect data on the factors that affect Grade 12 learners' receptiveness of SEA in the context of learning mathematics and actual use of the application, and to investigate the role played by demographic characteristics in Grade 12 leaners' receptiveness of SEA.

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The questionnaire comprised of two sections: Section A and Section B. The questionnaire was intended to collect data on the receptiveness SEA in the context of learning of mathematics by Grade 12 learners. The collected information was solely kept by the research team and was not disclosed to any third party and used for academic purposes only. Section A had three items intended to collect the respondents' biographical data: gender, residential demographics and how many hours they spent using SEA per week. The questionnaire was used to keep leaners' responses anonymous.

Section B was meant to answer the research question, "What are the factors that affect Grade 12 learners' receptiveness of SEA in the learning of mathematics?". Eight constructs were measured with no more than 5 indicators per construct which were measured on a five-point Likert scale with the alternatives ranging from 1 – strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – strongly agree. These indicators or items were intended to measure the Grade 12 leaners' receptiveness of SEA in the context of learning mathematics. The questionnaire was constructed and written in simple language for all respondents to understand. The aim of the study was clearly written on the first page, and it was clear to the respondents that the information was not going to be disclosed to any third party besides that it would be used for academic purposes only. Instructions were clearly indicated on how to respond to every question. Then the questionnaire was administered to 300 Grade 12 mathematics learners at uMhlathuze circuit schools under king Cetshwayo District in South Africa. The questionnaires were delivered and collected after they were filled in.

The present study has considered reliability, as internal consistency, called Cronbach's alpha, which is often called alpha coefficient of reliability or just alpha. Alpha is suitable for scales with many indicators/items amongst which it gauges internal consistency (Cohen *et al.*, 2018). According to Salloum *et al.* (2019), a reliability coefficient of 0.7 or above is deemed to be acceptable. In this study, the Cronbach's alpha value is 0.878, which reflect a significant reliability of the constructs (Hair *et al.*, 2019). Therefore, all the construct indicators were reliable, and hence, they could be used in the final study.

To test for validity of the instrument, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity were used (Kaiser, 1974). In this study, the KMO measure of sampling adequacy is greater than 0.5, while the significance level which is measured by the Bartlett's test of sphericity was less than 0.05. The overall validity of the instrument was 0.872, which indicates that the instrument was valid.

After considering the statistical reliability and validity of the instrument from the pilot study, some changes were made to the instrument: instructions on the instrument were clearly stated, but research topic was not included on the instructions, then it was included; some repetition of the indicators was removed from some constructs, PEOU, PA and AU of the instrument; and numbers were assigned in the codes, so that it easy for the respondents to reference, for example, PU1, PA1, and PSI2, etc.

2.4. Data analysis

In this study, the Statistical Package for the Social Sciences (SPSS) was used for the analysis of descriptive statistics focusing mostly on demographic data. For the main model data were analysed using partial least squares structural equation modelling (PLS-SEM) applying SmartPLS version 3.0. This methodology was chosen because of its ability to provide a comprehensive analysis of latent variables that are not directly observable. This speaks directly to the determinants of Grade 12 learners' receptiveness of SEA in learning mathematics. PLS-SEM was appropriate in this study because it predicted the factors that affect Grade 12 learners' receptiveness to SEA in the context of learning mathematics. In addition, the study aimed to develop and evaluate a new model (SEA technology acceptance model) to predict the factors that might affect the receptiveness of SEA to Grade 12 learners, that can be used by extending TAM.

2.5. Ethical Considerations

Researchers McMillan and Schumacher (2010) discussed the significance of ethical considerations – that the quantitative researcher must be delicate, informed and consider carefully the ethical standards according to the nature of the research topic. Permission was sought from all the other stakeholders before embarking on collecting data and gaining official permission to undertake research with the target population. Cohen *et al.* (2000) stated that getting permission to conduct research means contacting relevant people in writing. To that effect the researcher did the following:

i. A letter requesting authorization to conduct research was sent to the KwaZulu-Natal provincial head of the Department of Basic Education asking for consent to conduct research in chosen schools.
ii. A letter was also sent to the Circuit manager of uMhlathuze under King Cetshwayo District asking for permission to conduct research in high schools.

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iii. A letter was forwarded to the principals of the target schools at uMhlathuze circuits seeking permission to conduct the research.

iv. Permission to conduct the research was sought from the University of Zululand ethics committee.

v. Thereafter, permission was sought from the relevant Grade 12 leaners and parents using a detailed informed consent declaration which was given to learners to seek permission from their parents/guardian to participate in the study.

The researcher's application for ethical clearance was endorsed on 21 January 2022 and the ethical clearance number is UZREC 171110-030 PGM/283.

3.FINDINGS AND DISCUSSION

3.1. Findings

Demographics

In this section, an analysis of demographic data is given. The three demographic items are gender, residential location, and hours spent using the SEA application.

Gender

Out of 272 Grade 12 leaners who took part in the survey, both genders were fairly represented in the survey, as evidenced by the outcome as shown in Table 4.1. In all, 161(59.2%) respondents were females, while111 (40.8%) were males. In other words, females made up a marginal majority of the study participants.

Table 1: Gender distribution (N=272)

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	111	40.8	40.8	40.8
	Female	161	59.2	59.2	100.0
	Total	272	100.0	100.0	

Residential Demographics

The residential demographics of the respondents is shown in the Table 4.2, where the result 182 (66.9%) were respondents that were coming from rural Schools and 90 (33.1%) were from urban.

Table 2: Residential demographics distribution (N=272)

Residential demographics					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rural	182	66.9	66.9	66.9
	Urban	90	33.1	33.1	100.0
	Total	272	100.0	100.0	

Hours Spent using SEA

The respondents were asked about the number of hours they spend using SEA per week. The results shown in Table 4.3 reveal that 83 (30.5%) of the respondents indicated that they spend 1–2 hours per week, followed by 99 (36.4%) who indicated that they spend 3–4 hours per week, 54 (19.9%) indicated that they spend 5–6 hours per week, and 36 (13.2%) learners said they spend more than 7 hours per week on the application. A conclusion can therefore be drawn that most respondents who participated in this study spend an average of 3–4 hours per week using SEA to practice mathematics.

Table 3: Hours spent using SEA (N=272)

Hours spent on SEA					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 – 2 hrs	83	30.5	30.5	30.5
	3 – 4 hrs	99	36.4	36.4	66.9
	5 – 6 hrs	54	19.9	19.9	86.8
	7 or more hrs	36	13.2	13.2	100.0
	Total	272	100.0	100.0	

Effects of Demographic Variables on Receptiveness of SEA

The SEA technology acceptance model R-squared and the paths coefficients are shown in Figure 2, is made up of eight constructs (PA, PSI, PSR, CSE, PEOU, PU, ATT, and AU). PA, PSI, PSR, CSE, and PEOU, all predict PU. POEU is predicted by PA, PSI, PSR, and CSE. PEOU predicts PU, and they are both predictors of ATT and PSI. AU is predicted by PU, PEOU, and ATT. All the indicators loaded well. An initial test of 15 original hypothesis in this regard has been earlier published by Xulu *et al.* (2024).

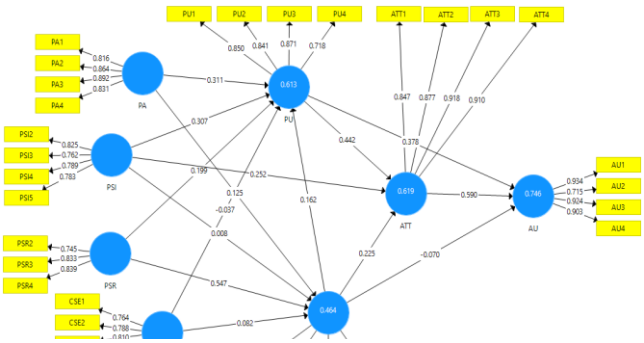

Figure 2: SEA Technology Acceptance Model (SEATAM)

PA: Perceived Accessibility PSI: Perceived Social Influence

PSR: perceived Skill Readiness CSE: Computer Self-Efficiency

PU: Perceived Usefulness PEOU: Perceived Ease Of Use

ATT: Attitude Towards Technology AU: Actual Usage.

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To determine the role played by demographic variables (gender, residential, and hours spent using SEA), in this study, multigroup analysis was used. This was done to understand whether demographics influence the actual use of SEA by Grade 12 learners. This study used a two-tailed t-test to assess the effect of demographics on the actual use of SEA. Therefore, the cut-off t-value was 1.96 (Klesel *et al.*, 2022).

Effect of the Gender Variable on Receptiveness of SEA

The results of the multigroup analysis of the gender variable are presented in Table 4. They indicate that only three paths were accepted. These are: ATT to AU ($t > 1.96$, $p < 0.05$), PSI to ATT ($t > 1.96$, $p < 0.05$) and PU to AU ($t > 1.96$, $p < 0.05$). The rest of the paths were not supported. These results imply that only these three pathways (Attitude Towards Technology (SEA) effect on Actual Usage, Perceived Social Influence effect on Attitude Towards Technology (SEA), and Perceived Usefulness effect on Actual Usage) are affected by gender.

Table 4: Multigroup analysis of gender variable (N=272)

Path	Path Coefficients-diff (Female - Male)	t-Value (Female-Male)	p-Value (Female-Male)	Decision
ATT -> AU	0.224	2.339	0.020	Accepted
CSE -> PEOU	-0.199	1.333	0.184	Rejected
CSE -> PU	0.035	0.260	0.795	Rejected
PA -> PEOU	0.105	0.663	0.508	Rejected
PA -> PU	-0.025	0.208	0.835	Rejected
PEOU -> ATT	-0.176	1.826	0.069	Rejected
PEOU -> AU	0.056	0.657	0.512	Rejected
PEOU -> PU	0.009	0.063	0.950	Rejected
PSI -> ATT	0.210	2.079	0.039	Accepted
PSI -> PEOU	0.025	0.141	0.888	Rejected
PSI -> PU	-0.021	0.139	0.890	Rejected
PSR -> PEOU	-0.073	0.509	0.611	Rejected
PSR -> PU	0.000	0.002	0.999	Rejected
PU -> ATT	-0.002	0.020	0.984	Rejected
PU -> AU	-0.306	2.719	0.007	Accepted

Effect of the Residential Location Variable on Receptiveness of SEA

This study used rural- and urban-based school contexts to examine the significant influence on receptiveness of SEA. The results of the multigroup analysis effect of the residential location variable are presented in Table 5 — a two-tailed t-test result between rural and urban locations. The results showed that two paths were accepted. These are ATT to AU ($t > 1.96$, $p < 0.05$) and PU to AU ($t > 1.96$, $p < 0.05$). The rest of the paths were not supported. These results imply that only these two pathways (Attitude Towards Technology (SEA) effect on Actual Usage, and Perceived Usefulness effect on Actual Usage) are affected by the residential location variable.

Table 5: Multigroup analysis effect of residential location variable (N=272)

Path	Path Coefficients-diff (Rural-Urban)	t-Value (Rural-Urban)	p-Value (Rural-Urban)	Decision
ATT -> AU	0.215	2.045	0.042	Accepted
CSE -> PEOU	-0.131	0.903	0.367	Rejected
CSE -> PU	0.010	0.075	0.940	Rejected
PA -> PEOU	-0,030	0.195	0.845	Rejected
PA -> PU	-0.125	0.973	0.332	Rejected
PEOU -> ATT	-0.196	1.885	0.061	Rejected
PEOU -> AU	0.099	1.210	0.227	Rejected
PEOU -> PU	0.042	0.293	0.770	Rejected
PSI -> ATT	-0.116	1.059	0.291	Rejected
PSI -> PEOU	0.327	1.827	0.069	Rejected
PSI -> PU	0.003	0.017	0.987	Rejected
PSR -> PEOU	-0.202	1.398	0.163	Rejected
PSR -> PU	0.095	0.657	0.512	Rejected
PU -> ATT	0.159	1.397	0.164	Rejected
PU -> AU	-0.281	2.531	0.012	Accepted

Effect of the Hours Spent Variable on Receptiveness of SEA

In this study, a comparison of leaners that spent maximum hours using SEA (five hours or more) versus those that spent minimum hours using SEA (less than five hours) per week were considered. The results in Table 6 show the multigroup analysis effect of the hours that Grade 12 learners spent using SEA to learn mathematics. They

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show that all paths were not supported by the results. This implies that hours spent have no significant effect on learners' receptiveness to SEA.

Table 6: Multigroup analysis effect of hours spent using SEA variable (N=272)

Path	Coefficients-diff (Maximum - Minimum hours)	t-Value (Maximum - Minimum hours)	p-Value (Maximum - Minimum hours)	Decision
ATT -> AU	-0.010	0.091	0.927	Rejected
CSE -> PEOU	0.124	0.835	0.405	Rejected
CSE -> PU	0.133	1.029	0.304	Rejected
PA -> PEOU	-0.274	1.633	0.104	Rejected
PA -> PU	-0.061	0.438	0.662	Rejected
PEOU -> ATT	0.043	0.394	0.694	Rejected
PEOU -> AU	-0.106	1.200	0.231	Rejected
PEOU -> PU	0.087	0.580	0.562	Rejected
PSI -> ATT	-0.069	0.691	0.490	Rejected
PSI -> PEOU	-0.052	0.296	0.768	Rejected
PSI -> PU	-0.123	0.817	0.414	Rejected
PSR -> PEOU	0.260	1.624	0.106	Rejected
PSR -> PU	0.079	0.528	0.598	Rejected
PU -> ATT	0.164	1.330	0.185	Rejected
PU -> AU	0.031	0.251	0.802	Rejected

3.2. Discussion

Gender

This study sets out to find out if there was any significant effect of gender in the receptiveness of SEA in the learning of mathematics by Grade 12 learners. The results indicated in Table 4 show that three paths show a significant difference on the receptiveness of SEA: ATT to AU ($t > 1.96$, $p < 0.05$), PSI to ATT ($t > 1.96$, $p < 0.05$) and PU to AU ($t > 1.96$, $p < 0.05$), while the rest of the 13 are not affected on gender. This implies that ATT and PU had a significant effect on AU of SEA and also PSI had a significant effect on learners' ATT. Most of the paths had no significant influence on the receptiveness of SEA. The findings of this study are consistent with those by Tshabalala *et al.* (2019), that gender has no effect on the relationship between pre-service teacher's use of Moodle to enhance learning. Overall, the outcomes of this study support Owusu-Bempah et al. (2022) who also report that both males' and females' LMS usage intentions were shown to be significantly influenced by system quality and service quality. In addition to this finding, information quality showed a statistically significant influence on males' LMS use intentions while having no effect on the LMS use intentions of females (Owusu-Bempah *et al.*, 2022).

However, Attitude Towards Technology (SEA) effect on Actual Usage, Perceived Social Influence effect on Attitude Towards Technology (SEA), and Perceived Usefulness effect on Actual Usage are all affected by gender. This outcome agrees with the findings of Alshehri *et al.* (2020) which revealed that both gender and age moderated a single association between the facilitating conditions and actual use of learning management systems where female and younger students exhibited higher perceptions of the association than did their counterparts. Similar multi-group analysis by Al-Azawei (2019) affirms that gender differences, however, had only a slight moderating effect on the relationship between e-learning self-efficacy and LMS acceptance. In terms of Perceived Social Influence effect on Attitude Towards LMS Technology Chatterjee (2023) reports that gender-based social influence is a moderating factor in LMS technology adoption. Similarly, for Perceived Usefulness effect on Actual Usage interacting with gender, the results of Al-Hamad (2022) revealed that the actual use of LMS was highly driven by perceived efficacy, whereas it was moderately influenced by facilitating conditions *such as* instructors' gender, experience, and field of study, as moderating factors. The path analytical results *by Edeh* et al. *(2021) also* revealed that lecturers' characteristic (experience and gender) have full mediation effects between the LMS skills possessed and level of LMS usage

Residential Location

In this study, the residential location of Grade 12 learners was included to find out how Grade 12 learners in various locations receive SEA in the learning of mathematics. The results in Table 5 indicated that out of 15 paths, only two were accepted: ATT to AU ($t > 1.96$, $p < 0.05$) and PU to AU ($t > 1.96$, $p < 0.05$); the rest were not supported. This result means that Grade 12 learners' ATT and PU have a significant effect on AU, which implies that their ATT and PU are affected by where they reside. Most of the paths were rejected, which implies that the residential location

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variable to a large extent does not influence the actual use of SEA. The findings of this study are contradictory to those by Syahruddin *et al.* (2021), whose results showed a huge difference when it comes to the acceptance of distance learning. Learning behaviour patterns and access to technology were revealed to be different in different locations.

The results imply that two pathways, namely Attitude Towards Technology (SEA) effect on Actual Usage, and Perceived Usefulness effect on Actual Usage are affected by the residential location. Invariably, learners from rural areas would be disadvantaged in actual usage of SEA due to existing socio-economic variables that put them at a disadvantage. This outcome supports the position of Afolabi and Ajani (2023), who observed that research has shown that students enrolled in rural educational institutions encountered a range of obstacles when attempting to access or utilize learning management systems (LMS) as the sole substitute for traditional in-person classes or hybrid learning models, both before, during and after the period of COVID-19 lockdown. Similar outcomes were arrived at by the results Wang *et al.* (2022) showed that the intention of students in the village to use tablet computers as learning media is influenced by hedonic motivation and task technology fit. In contrast, habit and task technology fit is the most significant factor for students in urban areas to use tablet computers as learning tools (Wang *et al.*, 2022). Evidently, there is the need to design more LMS platforms that can conveniently help rural students to be academically competitive with their urban counterparts.

Similarly, this study found that Perceived Usefulness effect on Actual Usage is affected by the residential location. The implication is that the perceived usefulness of the Siyavula Learning Management System (LMS) significantly influences its actual usage; however, this relationship is moderated by the learners' residential location. Learners in urban areas often have better internet connectivity, reliable electricity, and access to digital devices, which enables them to experience the full benefits of the SEA LMS – thereby reinforcing their perception of its usefulness and increasing usage. Conversely, those in rural or underserved locations may face infrastructural limitations that hinder their ability to engage with the LMS effectively, regardless of their belief in its usefulness. As a result, even if rural learners perceive the LMS as beneficial, actual usage may remain low due to contextual constraints, suggesting that residential location plays a critical role in translating perceived usefulness into practical engagement. To tackle this challenge, researchers have suggested specific efforts tailored to ameliorate the situation with rural learners. In this regard, Rarugal and Sermona (2024) have tested LMS system that intends to make sharing educational resources easier, such as to let students access their lessons, modules, and assignments, take exams and quizzes and even watch video lessons on their laptops, smartphones, and tablets, even without an internet connection. Relatedly, Safdar *et al.* (2022) recommends Cloud-based Virtual Learning Environment (C-VLE) that can help rural students to be academically competitive with their urban counterparts.

Hours Spent Using SEA

In this study, the hours spent by Grade 12 leaners using SEA per week were included to find out whether the hours spent using SEA between maximum (5 hours or more) and minimum (less than 5 hours) hours spent have a significant difference in learners' responsiveness to SEA. The results in Table 6 show that there is no significant difference because all tested paths had no significant effect on receptiveness to SEA.

Thus, the findings of this study on usage duration were not expected, considering the fact that the duration of usage activities was expected to significantly impact learners' receptiveness to a Learning Management System (LMS) (Bailey *et al.*, 2023). Initially, users may face challenges in navigating the SEA platform, leading to resistance or low engagement. However, as learners spend more time using the SEA LMS, they become more familiar with its features, interface, and potential benefits, which can enhance their confidence, reduce cognitive load, and foster a more positive attitude toward its use. Prolonged exposure often leads to increased trust and appreciation of the system's role in facilitating learning, thereby improving overall receptiveness. Thus, consistent and extended usage contributes to greater acceptance and integration of the LMS into learners, academic routines.

4. CONCLUSIONS

4.1. Conclusion

The main aim of this study was to examine the factors that affect Grade 12 learners' receptiveness of the SEA in the context of learning mathematics with particular reference to the demographic variables of gender, residence and duration of usage. In order to achieve this, the study developed the model which was used to answer the research objectives of this study. The model of this study (SEATAM) had eight constructs. The eight factors identified in this study all play an important role in Grade 12 learners' actual usage of the application, which means

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that they all influence the receptiveness of the SEA as affirmed by Xulu *et al.* (2024). About the actual usage of the application by Grade 12 learners in learning mathematics, it was established that the identified variables for the proposed SEATAM were the good predators of the Grade 12 learners' receptiveness of the application. The demographics of residential location, gender, and hours they spent did have some specific pathway effect on the actual use of the Siyavula LMS application.

Theoretically, the SEATAM model tested the relationship between PEOU and AU, the results revealed that the relationship is nuanced. This supports TAM because originally that relationship was not there in the original TAM. Even though TAM was developed decades ago, it is still useful to explain the acceptance and receptiveness of technology even up today. This study has managed to contribute to theory that these external variables (PA, PSI, PSR and CSE) can be added to TAM to explain the receptiveness of SEA by grade 12 learners.

In conjunction with earlier outcomes of Xulu *et al.* (2024), Figure 2 demonstrates the SEATAM model with ten supported hypotheses and constructs that were retained: PA, PSI, PSR, PU, PEOU, ATT and AU. CSE was taken out because all its hypotheses were not supported.

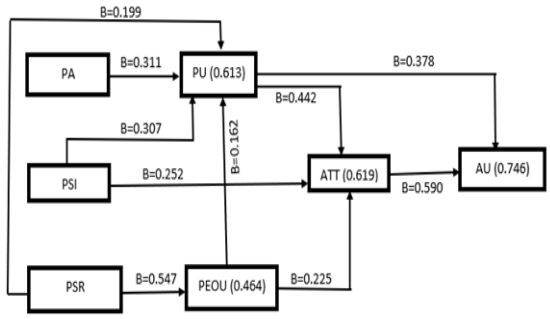

Figure 3: SEATAM Grade 12 leaners' actual use of the application

This study contributes to the field of new technology usage, user acceptance research, receptiveness, and information systems.

4.2. Suggestions

The study has contributed to the body of knowledge by examining the factors that might affect Grade 12 learners' receptiveness of the SEA in the context of learning mathematics by Grade 12 learners at uMhlathuze circuits under King Cetshwayo District. In modern times, daily life depends much on the use of technology in many and various ways. However, learning has mostly resumed through online platforms. This presented an even more pressing need for the launching of software applications such as the SEA, specifically in Grade 12.

Based on the findings of this study, the following recommendations are made:

i. The Department of Basic Education (DBE) should use offline portals to support learners with accessibility of the application. This will facilitate the seamless usage of the Siyavula Educational Application in rural areas where internet access may be a challenge.
ii. The DBE should do awareness programmes on the usefulness of SEA. Such awareness programmes will lead to schools fully leveraging the full capacity of SEA to enhance academic performance and technological prowess for learners.

The results of this study suggest that teachers should equip their learners with skills needed to learn mathematics using SEA and other educational software. There is the need for capacity building for learners to ensure the continuous usage of SEA

Ethical Approval Declaration

Not applicable.

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Data availability:-

The datasets generated and analysed during the current study will be available from the author upon reasonable request**.**

Consent for publication:-

I hereby provide consent for the publication of the manuscript detailed above**.**

Competing interests:-

The authors declare no competing interests.

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