Research Article

A comparative study of pupils' performance during online and face-to-face learning in under resourced secondary schools of Bulawayo, Zimbabwe

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ABSTRACT

Onset of COVID-19 early 2020 disrupted learning in public and private schools of Zimbabwe. The traditional face-to-face lesson delivery method was no longer feasible due to lockdowns. The purpose of this research was to establish whether or not performance in under-resourced schools was affected. The research compares performance of learners prior to and during COVID-19 period in arts, commercial and science subjects. A simple random sampling method was used to collect primary data from advanced level students, teachers and other stakeholders using questionnaires. Secondary data on performance of learners was collected randomly from reports from public schools within Bulawayo. Evaluation of structural associations between learning areas, teaching methods and subject areas were analysed using loglinear models. Findings of the research show that arts and commercial subjects could be taught online without statistically significant changes in the odds of passing these learning areas. While science subjects had statistically significant changes in the odds of passing these learning areas when a shift from face-to face to online learning was made. Girl child was the most affected. It is recommended that for science subjects, mixture of online learning and face-to-face lessons be considered.

Keywords: SARS-CoV-2, face-to-face and online, performance, under-resourced, schools in Zimbabwe

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INTRODUCTION

Technology advancement is the talk of the 21st century and Zimbabwe is no exception in this talk. Most learning in developed and developing countries is online (Almanthari et al., 2020; Ferri et al., 2020; Simpson, 2018). This has been highly exacerbated by the outbreak of COVID-19 in early 2020. Zimbabwe was not prepared for the pandemic and COVID-19 regulations had to be exceedingly observed to reduce the spread of the pandemic. Social distancing was a necessity to avoid unwanted deaths in Zimbabwe due to the pandemic. This forced schools to stop face-to-face lessons in primary and secondary schools in Zimbabwe. This was the case to tertiary institutions as well since no lectures were conducted during the peak periods of COVID-19 (Ullah & Ali, 2021).

During COVID-19 peak period, online lessons were famous compared to face-to-face lessons. This was because there were no strategies or corrective measures in place to reduce the spread of the pandemic. No sanitizers were available, masks were still in short supply, and hence conducting face-to-face lessons was not possible. This therefore propelled the online teaching in almost all Zimbabwean primary, secondary and tertiary institutions of learning.

Given the plethora of problems faced by educational institutions of Zimbabwe (Mwembe et al., 2022), online learning is a challenge. These challenges could be institutional, at teacher level or can be at pupil level. Institutional include lack of infrastructure to conduct online lessons. This includes availability of laptops, smartphones, electricity, Wi-Fi provision, etc. in schools to conduct online lessons (Maphosa, 2021). Online lessons could not be conducted if some of these gadgets and infrastructure were not available at a given school.

At teacher level, some teachers might not be familiar with use of laptops and connection to Wi-Fi could be a challenge to some teachers. This implies teachers deserve training before they fully get involved in online teaching. Teachers could at times not have smartphones to conduct online teaching. This presents a great challenge to the teacher and conducting lessons on borrowed gadgets would not work well.

Pupils had their own challenges. Firstly, they might not have phones and network to attend an online lesson. This presents a great challenge to start an online lesson for a class with pupils without smart phones or pupils with network problems. Secondly, parents need to understand online teaching as pupils will be at home with parents and disturbances will be minimized if parents are aware of what online teaching is.
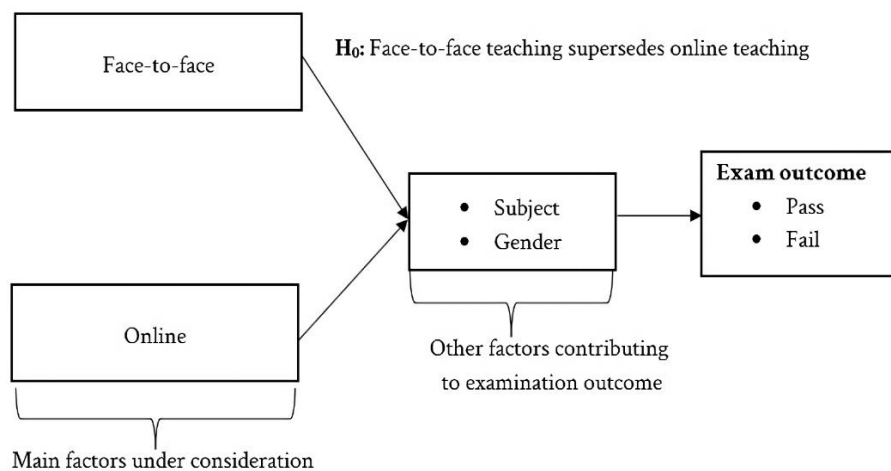
Figure 1. Conceptual framework of the research (Source: Authors)

In this research, concentration is on public schools and not private schools. Private schools have donors that might make them swiftly respond to some of the circumstances brought about by COVID-19. Hard hit schools were public schools compared to private schools (Berger et al., 2022; Haider et al., 2021; Zinyemba et al., 2021). Most schools under consideration are in Bulawayo and surrounding areas where network is believed to be not a problem and pupils are more affluent compared to rural pupils.

The argument is that, if pupils in areas with network and infrastructure for online teaching are failing, it implies rural schools can virtually not manage online teaching (Nhongo & Tshotsho, 2021). If urban school pupils are passing, then it is possible to conduct online teaching in Zimbabwe given the infrastructure for online learning. The research assumes that face-to-face teaching methodology supersedes online teaching methodology. The conceptual framework of the research is as depicted in **Figure 1**.

Online learning definitions by Barrot et al. (2021) and Singh and Thurman (2019) were adopted in this research and face-to-face are purely traditional methods of teaching without use of internet and computers to deliver a lesson. Online learning was found as an alternative to face-to-face learning method during COVID-19 pandemic period. This was adopted as an apt way of continuing with learning in many educational sectors (Bankole, 2022; Bryson & Andres, 2020; Castro & Tumibay, 2021; Patra et al., 2021; Verma et al., 2021).

Purpose and Rationale

The untimely advent of coronavirus gravely disturbed smooth learning in most disadvantaged schools. Government schools were highly affected compared to private schools (Zinyemba et al., 2021). To circumvent the spread of the disease, closure of schools made face-to-face learning impossible. An alternative to face-to-face was online learning. Most schools, irrespective of its economic status, was forced to conduct lessons online. This exposed most schools, as they were not prepared to make a sudden shift from face to face teaching methodology to online methodology. There were many hindrances to this drastic shift. Schools do not have infrastructure that can allow online teaching. No access to internet and at times no power to switch on the computer, if ever available. Many other factors are facilitator related.

Having explained this plethora of problems, knowledge on best way of delivering lessons is imperative. Does teaching of art subjects, commercial subjects and science subjects require same treatment given the infrastructural and teacher related problems at hand? Proper diagnosis of this problem will help come up with a strategy to have some subjects taught online while others are on face-to-face teaching method. This is because, in Zimbabwe, coronavirus is more severe in winter as compared to summer (Dzinamarira & Musuka, 2021).

Understanding of students' performance in different academic fields will foster a plan on which methodology of teaching for which subject area during the coronavirus period. The best way can either be online, face to face or a mixed strategy. Alternatively, teach theoretical subjects online during peak periods of COVID-19 and teach practical subjects during off-peak periods of COVID-19. Clear answers will come after analysis of the performance of students in different subject areas under different teaching methodologies.

METHOD

Data Collection

Data collection was threefold. A questionnaire was administered among the students, parents, teachers and other stakeholders to collect perspectives of online and face-to-face teaching by these stakeholders. There were four different questionnaires. There were questionnaires for students, parents, teachers, and other key informants from the Ministry of Primary and Secondary Education. Data from questionnaires were captured, cleaned, and analyzed using SPSS version 23.

The second way was use of focus groups to collect the perspectives of online learning from students, teachers and parents. Use of focus group discussions with students was indispensable to allow a platform where students could say their views about online and face-to-face teaching methodologies. The first two ways collected primary data and the third way was to collect secondary data from schools' reports. Pass rates prior COVID-19 and posterior COVID-19 were collected. In both cases, a simple random sample was used in determining the students, teachers, parents, schools and other stakeholders to include in the study.

Loglinear modelling was used to analyze secondary data for structural associations between the factors influential in examination output. The analysis was to check whether passing or failing an examination is associated with gender, teaching methodology or learner's area of study, that is, arts, commercials or science subjects.
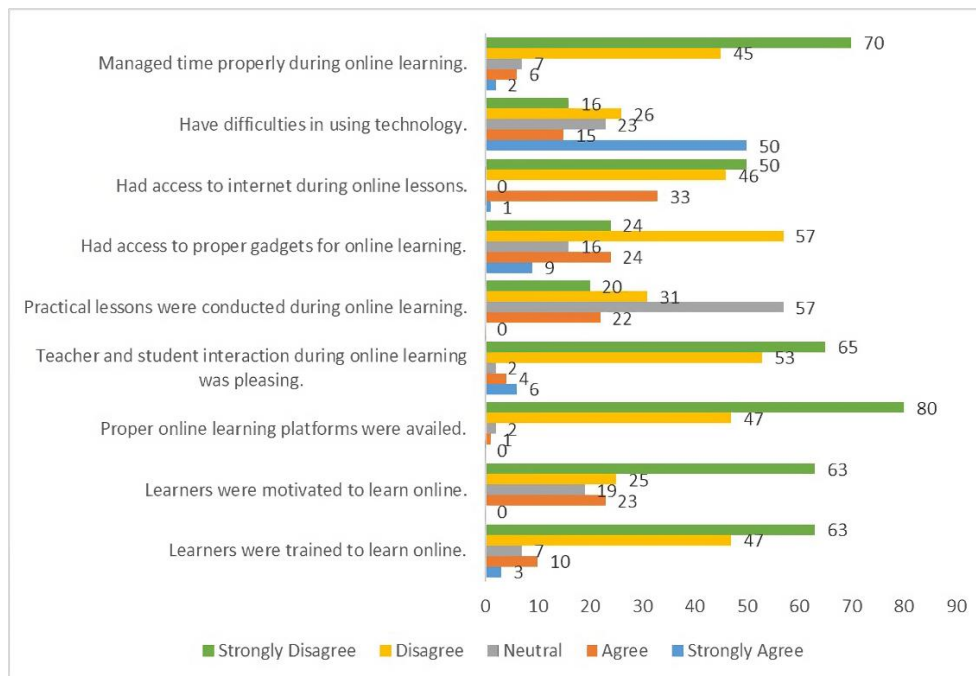
Figure 2. Factors discouraging successful online learning in public schools (Source: Authors)

Analysis of data

Primary data analysis

The target population were advanced level students in under-resourced schools in Bulawayo. There were 70 female learners and 60 male learners in the sample. Questionnaires were distributed to 130 respondents. From the 130 respondents, 43 were from sciences department, 44 were from the commercials department and 43 were from the arts department. Responses from questionnaires were summarized in **Figure 2**.

An analysis of some of the factors contributing to successful online learning was conducted. The research found out that most learners did not manage time properly during online learning, had difficulties in using technology. These difficulties included use of smart phones, joining Google Classroom, had no access to internet, had no proper gadgets for online learning, teacher and learners interaction during online learning was not possible and no proper online learning platforms were availed. The common learning platform among learners was WhatsApp. There were also challenges of self-motivation by learners to attend these online lessons.

If learners lack self-motivation, grasping of concepts become difficult. They need to be motivated first before attending online lessons for them to grasp the taught concepts easily. This could possibly be due to lack of training on how to make use of online lessons by learners. Both parties, teachers and learners, need to be taught on how to maximize usage of online learning platforms.

In summary, most learners did not prefer online learning. The research found out that 71.5% confirmed that they would not prefer online learning, implying that they prefer face-to-face learning to online learning. While 28.5% of the learners confirmed that they prefer online learning. This does not imply that online learning is bad, it is associated with many needs that learners currently do not have. They are not yet used to online learning but with time, we believe that it will be a convenient way of delivering a lesson.

Secondary data analysis

School records provided secondary data. These were collected from school records. Data was for 2017-2019 school academic calendars before the onset of COVID-19 and 2020-2021 school academic years during COVID-19 pandemic. In 2017-2019 period, there was principally face-to-face teaching and rarely online teaching and is therefore regarded as face-to-face learning period. After the onset of COVID-19, 2020-2021, lockdowns were introduced, and face-to-face lessons could not be conducted. Most common teaching methodology was online. During COVID-19 era, we assume online methodology was more prevalent compared to face-to-face methodology. All teaching that went on during COVID-19 period is regarded as online teaching as most of the teaching was online.

Data for 1797 students were collected. This included information on teaching methodology, gender, area of study and examination outcome. Examination outcome means whether students passed or failed the examination of a particular academic year. Examinations under consideration were for the upper six students in arts, commercials and science subjects.

Secondary data revealed that, of the 1,797 students, 900 (50.1%) students had face-to-face lessons and 897(49.9%) had online lessons. There were 970 (54%) males and 827 (46%) females. These students either passed or failed their examinations. Results show that 1467 (81.6%) passed and 330 (18.4) had failed their examinations. There were three areas of study under consideration. These were arts, commercials, and sciences. It is clear that 632 (35.2%) of the students were doing Arts, 439 (24.4%) were doing commercials and 726 (40.4%) were doing Sciences. We need to understand whether teaching strategy, online or face to face, is associated with students' performance. Further, is gender and study area associated with students' performance? Similarly, we need to check whether gender is associated with teaching method and other interactions need investigation to understand students' performance.

Table 1. Number of students in each category

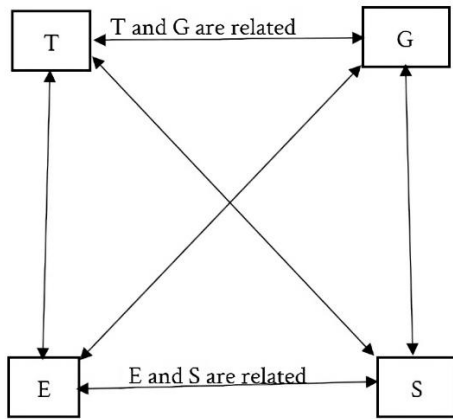|	Gender	Examination outcome	Subject combination		
			Arts	Commercials	Sciences
Teaching method					
Face-to-face	Male	Passed	116	94	187
		Failed	2	37	55
	Female	Passed	196	88	86
		Failed	2	33	4
Online	Male	Passed	131	65	181
		Failed	3	22	77
	Female	Passed	168	75	80
		Failed	14	25	56

Figure 3. Diagrammatic representation of structural associations between variables (Source: Authors)

In order to understand the interactions, **Table 1** was found to be useful from secondary data. A loglinear model was applied and the following model was found. Letting T=Teaching strategy (face-to-face or online), G=gender of student (male or female), E=Examination outcome (fail or pass), and S=study area (arts, commercials, or sciences).

A saturated loglinear model T*G*E*S was found. This infers that the general model is:

$$\log(\mu_{ijkl}) = \lambda + \lambda_i^T + \lambda_j^G + \lambda_k^E + \lambda_l^S + \lambda\ T_i^{TG} + \lambda_{ik}^{TE} + \lambda_{il}^{TS} + \lambda_{jk}^{GE} + \lambda_{jl}^{GS} + \lambda_{kl}^{ES} + \lambda_{ijk}^{TGE} + \lambda_{jkl}^{GES} + \lambda_{kli}^{EST} + \lambda_{lij}^{STG} + \lambda_{ijkl}^{TGES},$$

where λ represents an overall effect or a grand mean (on the log scale) of the expected counts, and it ensures that $\sum_i \sum_j \sum_k \sum_l \mu_{ijkl} = n$, λ_i^T, λ_j^G, λ_k^E, λ_l^S represent the impact of each of the variables, T, G, E, and S on academic performance, λ_{ij}^{TG}, λ_{ik}^{TE}, λ_{il}^{TS}, λ_{jk}^{GE}, λ_{jl}^{GS}, λ_{kl}^{ES} represent the association between two variables while controlling the third and reflect the departure from independence, $\lambda_{ijk}^{TGE} = \lambda_{jkl}^{GES} = \lambda_{kli}^{EST} = \lambda_{lij}^{SEG}$ represents association between three variables and reflect the departure from independence, and λ_{ijkl}^{TGES} represents the association between four variables and reflect the departure from independence.

T*G*E*S implies that there is association between all variables under study. There is a direct connection between each variable to the other, even though only two pairs are labelled in **Figure 3**. This further confirms that collapsibility theory is not applicable in this research.

Interpretation of results is based on the following definitions of adjusted odds ratio (AOR):

1. If AOR=1, exposure does not affect odds of outcome, meaning the odds of the event happening are exactly the same in the exposed versus the non-exposed group.

2. If AOR>1, exposure associated with higher odds of outcome.

3. If AOR<1, exposure associated with lower odds of outcome.

There are two teaching methods used in this research and these are face-to-face and online method. Using the above model, following results were obtained. Male students on face-to-face learning methodology are 22.83 times more likely to pass arts subjects compared to commercials (AOR=22.83, 95% CI=5.36-97.19, p=0.001). When compared to sciences, they are 34% more likely to pass sciences compared to commercials (AOR=1.34, 95% CI=0.84-2.17, p=0.24) and are 17.06 times more likely to pass arts as compared to sciences (AOR=17.06, 95% CI=4.08-71.27, p=0.01). Generally, they are doing well in arts compared to other study areas.

Female students on face-to-face learning strategy are 36.75 times more likely to pass arts compared to commercials (AOR=36.75, 95% CI=58.63-156.56, p=0.001). Females on face-to-face learning methodology are 8.1 times more likely to pass sciences as compared to commercials (AOR=8.06, 95% CI=2.74-23.72, p=0.001). In comparison to arts and sciences, females on face to face learning strategy are 4.56 times more likely to pass arts compared to sciences (AOR=4.56, 95% CI=0.82-25.36, p=0.059). This shows that females are doing well in arts and sciences compared to males on the face to face learning platform.

Similarly for online learning, males are 14.78 times more likely to pass arts compared to commercials (AOR=14.78, 95% CI=4.27-51.19, p=0.001). This indicates that males performed better in arts under face to face learning strategy as compared to online learning methodology.

During online learning, males are 26% more likely to pass commercials as compared to sciences (AOR=1.26, 95% CI=0.72-2.18, p=0.42). Instead of performing better in sciences as it is in face-to-face learning, male students are doing much better in commercials. This is highly likely due to the fact that sciences are more practical than arts or commercials. This signifies the difficulty of teaching these science subjects online in under resourced schools.

In comparison to arts and sciences, male students are 18.58 times more likely to pass arts as compared to sciences (AOR=18.58, 95% CI=5.74-60.16, p=0.001). The odds increase as compared to when face to face lessons are conducted. This is due to increased failure rate in science subjects when online teaching is conducted. It shows that students perform better in arts when taught online as compared to face-to-face learning.

Female students are four times more likely to pass arts subjects compared to commercials when taught online (OR=4.00, 95% CI=1.97-8.13, p=0.001). It is clear the odds of passing dropped from 36.75 to 4. This has implications on the performance of the girl child. The performance is nine times better when attending face-to-face lessons compared to online lessons.

If online lessons are conducted, other factors held constant, female students are 2.1 times more likely to pass commercials as compared to sciences (AOR=2.1, 95% CI=1.19-3.70, p=0.01). Initially when face-to-face lessons were conducted, female students did well in sciences compared to commercials. When online lesson are conducted, female students are doing better in commercials as compared to sciences. It indicates that when attending face-to-face lessons, female students' performance in sciences is approximately 17 times better than when attending online lessons.

Finally, female students are 8.4 times more likely to do well in arts as compared to sciences (AOR=8.4, 95% CI=4.42-15.98, p=0.001). Due to increased failure in sciences, the performance becomes much better in arts than in sciences when attending online lessons as compared to face to face lessons.

The research findings show that male students are 33% more likely to pass arts when attending face to face lessons than when attending online lessons, holding other factors constant (AOR=1.33, 95% CI=0.22-8.09, p=0.78).In the case of commercials, male students are 16%more likely to pass commercials when attending online lessons than face to face lessons (AOR=1.16, 95% CI=0.63-2.51, p=0.63).Male students were 45% more likely to pass sciences when attending face to face lessons than when attending online lessons(AOR=1.45, 95% CI=0.97-2.16, p=0.07). Differences in teaching methods were statistically not different for male learners. Performance was not different for male learners during face to face and when online teaching method was used.

In the case of female students, they were 8.2 times more likely to pass arts during face to face lessons than during online lessons (AOR=8.17, 95% CI=1.83-36.45, p=0.001). On a similar note, female students were not performing differently in commercials during face to face and during online lessons. Female students were 13% more likely to pass commercials during online lessons than when attending face-to-face lessons (AOR=1.13, 95% CI=0.62-2.06, p=0.70). As for science subjects, during face to face lessons female students were 15 times more likely to pass sciences than when attending online lessons (AOR=15.05, 95% CI=5.22-43.40, p=0.001). As for the girl child, the performance changed adversely in arts and sciences when there was a shift from face to face teaching to online teaching. The change in commercials was not statistically significant and hence performance during face-to-face lessons was the same as that of online lessons.

The female student is the most affected academically with COVID-19 lockdowns and curfews. The change in performance among male students from face-to-face to online learning was not as much as the change experienced in the performance of female students. The performance of the girl child was highly affected by the sudden shift from face to face learning to online learning given the inadequate infrastructure in schools.

DISCUSSION OF THE RESULTS

Onset of COVID-19 has brought in a colossal change to the way lessons are conducted in the education sector. Rarely were lessons conducted online and face-to-face used to be a standard and effective way of delivering lessons in schools. Due to measures used to combat spread of COVID-19, which do not promote gatherings, face-to-face lessons could hardly be conducted in classrooms. This forced reliance on online lessons. The change had a drastic negative effect on the performance of learners in under-resourced schools.

It was found that most students prefer face to face lessons compared to online lessons. These findings are consistent with what Ana et al. (2020), Iglesias-Pradas et al. (2021), Jovanovic et al. (2019), and Serhan (2020) found. This makes face to face be preferred over online learning. Online learning is highly independent learning in that the facilitator will not be close to the learner. This implies that, without self-motivation and discipline to learning, learners might not listen to what the teacher is teaching.

As stated by Korkmaz and Toraman (2020), Sadeghi (2019), Silalahi et al. (2020), and Yu (2021) more individual responsibility is associated with online learning. For learners to do well, individual discipline in learning is imperative. The research found out that online is more user friendly with arts subjects compared to science subjects. These findings are in line with what Korkmaz and Toraman (2020) and Simamora (2020) found.

Other factors that make online learning less favorable especially in under resourced schools include poor internet connections, un-affordability of smart phones, lack of training on effective utilization of online learning platforms by both learners and teachers and complexity of conducting practical lessons online. These were echoed in research done by Adarkwah (2021), Almaiah et al. (2020), Baticulon et al. (2021), Dhawan (2020), Howard et al. (2020), and Nhongo and Tshotsho (2021).

The findings of this research revealed that online teaching has reduced performance of learners especially in science, technology, engineering and mathematics (STEM) learning areas. These findings echo what was found by Whitley et al. (2021) in Canada of vulnerable learners. In low income countries, most schools have inadequate infrastructure, and most learners are at risk. These findings are also in line with what Andersen et al. (2022) found.

The research also established that the traditional method of face-to-face teaching was better than the online teaching especially in under-resourced schools. These findings are in line with what most scholars found in different research. Hashemi (2021b) found that there are many challenges associated with online teaching and computers and infrastructure are some of them. In his second research, Hashemi (2021a) found that face-to-face teaching method was mostly preferred as compared to online teaching method. This is in line the findings of this research. Most pupils and teachers preferred face–to-face learning and teaching method, respectively.

The research also found that gender had an association with performance under a specific learning method. The findings showed that girls' performance was the most negatively affected. The performance pre-COVID-19 era was nine times better that during COVID-19 era. These results are consistent with what Giusti et al. (2021) found in Italy that gender had an influence on academic performance among university students. This was also echoed by Plan International (2021) on their study in 14 countries that female students were not performing at par with their male counterparts during the pandemic era.

The research results are also consistent with what Muthuprasad et al. (2021) found in India that, during COVID-19, shift to online was adhered to but this does not completely apply in practical subjects. In sciences as compared to Arts and at times commercial subjects,

experiments need to be done. This can hardly be conducted online. Explanation of formulae used in mathematical subjects need explanation unlike in arts subjects where there are very minimum practicals and formulae to be explained. This explains the performance in sciences dropping during online lessons as compared to face-to-face lessons. Same findings were reached at by Mahdy (2020) of challenges of online learning especially in science subjects.

In conclusion, there are structural associations between gender, learning area, teaching methodology and performance of learners. Academic performance of learners in under-resourced schools is dependent on whether they are male or female, teaching is done on face-to-face basis or is done online and on whether learners were enrolled in arts subjects, commercial subjects or in science subjects.

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