Factors Affecting Students' Performance, Enrolment and Retention in Science Subjects in Secondary Schools in Uganda: A Case Study of Kigezi Region of Uganda

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Abstract

In this paper, we investigate the teaching of science subjects before and after the lockdown and explore the factors that affect students' confidence in passing national examinations. The research was carried out in the districts of the Kigezi region in Uganda, where 435 students from 12 schools and 60 science teachers provided both qualitative and quantitative data on the state of science education before, during and post the Covid-19-induced lockdown through interviews and questionnaires. Multiple regression analysis was performed to establish the relationship between syllabus coverage, practical coverage, likability of the science subjects, and confidence in passing both school and national examinations. We note that poor syllabus coverage and lack of adequate practical time are often blamed for the poor pass rates in science subjects in secondary schools in Uganda, but this research indicates that blaming these two alone is simplistic at best. Our results show that although the two factors are important to students by themselves, they are not the only determinants of students' confidence in success in national examinations. We show that subject likability is an indispensable determinant of students' confidence in passing science subjects in national examinations, and together with practical teaching as well as syllabus coverage, a winning formula for improving confidence in passing and ultimately enrolment is obtained. From this, we conclude that

improving students' attitude and perception of science should be emphasized as much as advocacy for practical teaching and completion of the syllabus in time. This will improve students' perception and performance in the sciences with the overall effect of boosting retention rates in STEM subjects.

Keywords: *STEM; multiple regression; Covid-19; science enrolment; student motivation; likability*

Introduction

The teaching of science subjects in all secondary schools in Uganda has been compulsory at O' level since 2005. The policy was followed by a reduction in the number of government-sponsored students doing arts at university level and an increase in the proportion of science students sponsored by the state at university level (Kabunga, Mohamed & Mnjokava, 2016). Despite the policy efforts by the Ministry of Education, performance in science subjects at O' level (in the national examinations) has been persistently poor through the years and enrolment at A' level is still very low. This continues to worry the Ministry of Education and the Government of Uganda (Africanews, 2017; Uganda National Commission for UNESCO, 2017). According to the Uganda National Examinations Board (UNEB), poor performance has been attributed to poor syllabus coverage and lack of adequate preparedness to handle practical components of the subjects (*The Monitor*, 2019, March 1). Indeed, many students face anxiety in handling science apparatus and making observations due to inadequate practice, yet this is only the first phase of scientific experiments (Ghartley-Ampiah, Tufuor, & Gadzekpo, 2004).

This presents challenges in attaining the national development goals set up by the government. The emergence and spread of Covid-19 challenged science education worldwide. For example, Yu et al. (2022) notes that the shift to online learning posed a particular challenge to instruction in science subjects and courses where hands-on training and collaboration are required. They also found that marginalized groups of students in sciences were disproportionately burdened by the pandemic-induced shift to online learning. In Uganda, the year-long Covid-19-induced lockdown acerbated the problems of science education by keeping many students away from school with little to no formal education.

According to a study by the MasterCard Foundation (MasterCard Foundation, 2021), enrolment for secondary school education in Uganda has been increasing steadily yet that same growth is not proportionately reflected in enrolment for science education. This has resulted in a shortage of skilled professionals in science-related fields. For instance, laboratory sciences and systems are among the most neglected components of the health systems in Uganda, with only 50% of the posts for laboratory technologists filled (Kiwanuka et al., 2020), highlighting a need for more scientists to reduce the heavy workload on those available. In order for students to continue with STEM (Science Technology, Engineering and Mathematics) subjects at post-secondary institutions and STEM careers later on, they need to perform adequately well in UNEB examinations, as these are used to determine students' achievement and progression to higher levels of education in the country. Poor academic achievement has been linked to poor economic development of individuals and their social economic status (Kabunga et al., 2016).

We also note that since students with poor results in the sciences are not selected to continue with STEM subjects at the university level, the country does not produce enough skilled professionals

in STEM fields to support its growing population (ADF 2012). This puts excess pressure on the few professionals available. These challenges existed before the emergence of Covid-19 in 2019, and the consequent lockdown in 2020 and 2021 only worsened this reality (Schults, Callahan, & Miltiadous, 2020). The drastic changes in the education system that followed the Covid-19 pandemic threaten to make education achievement, enrolment and retention figure in the sciences worse than they already are due to rampant dropout rates and poor achievement of learning outcomes, resulting in even worse performance. The World Bank report of 2020 estimated that school closures not exceeding five months could lead to falling test scores and to as much as a 25% increase in the number of children in lower secondary school levels with skills below the expected minimum level of proficiency. This paints a very bleak picture for science education in Uganda, where the lockdown stretched for more than a year. There is an urgent need to take deliberate steps to strengthen the teaching and learning of sciences, as well as steps to encourage students to enroll in the sciences and bolster students' understanding and achievement. Otherwise, the situation threatens to weaken government development plans and slow down the transformation of the country to middle-class status.

Uganda's Vision 2040 notes that Science, Technology, Engineering and Innovation (STEI) has a high potential to transform communities and increase the country's productivity and competitiveness. However, Uganda has not fully participated in the technological revolution taking place in the world and the country lacks adequate people in technology and scientists (ADF, 2012). Furthermore, the National Development Plan III (NDP III), section 2.4.1 notes that in order for the country to meet its national and international obligations (SDG goals, Africa Union Agenda 2050 and East Africa Vision 2063), the country needs to invest substantially in science, technology and innovation. This starts with giving adequate quality training to its youth to prepare them for the industrial clusters, engineering and innovation hubs that are to be built by the government (Uganda Vision 2040, section 4.2.4). Furthermore, countries around the world cannot afford to have populations with little to no interest in science since some scientific inventions come with ethical and social issues whose solutions need to go beyond science itself (Galvao, Reis, Freire, & Almeida, 2010). Hence the need for a good quality science education at secondary school level, even for students who may not wish to pursue a career in sciences.

In this paper, we tested the commonest hypotheses that have been repeatedly put forward by the UNEB concerning poor performance: that poor syllabus coverage and lack of adequate practical experience are the major sources of the high failure rates (*The Monitor*, 2019, March 1). Twahirwa and Twizeyimana (2020) argue that practice-based teaching is core to science learning and improves test scores in physics, while Shana and Abulibdeh (2020) carried out research on tenth grade chemistry and biology students and their results confirmed that practical work improved test scores. From this perspective, the claim by UNEB appears to be partly true. Despite the improvements in the provision of laboratory equipment in government-aided schools, performance continues to be low, so we seek to determine whether there are other factors affecting students' performance in UNEB examinations. We also felt that the quantity of practicals performed should be positively correlated with the amount of syllabus that is covered. It has also been suggested that increasing the number of practicals improves students' likability of the subject. We tested this hypothesis as well. Against this background, some of the hypotheses we had before embarking on the research was that inadequate practicals and poor syllabus coverage were the leading cause of poor performance in science subjects in Uganda and set out to determine the extent to which these factors affected students' confidence in passing UNEB examinations.

Research Objectives

The objectives of this research are: to determine the effect of practical work and syllabus coverage on student performance in science subjects in UNEB examinations; and to investigate the relationship between likability, practicals, syllabus coverage, school assessments and students' confidence in their ability to pass national examinations (UNEB).

Methodology

This research focuses on secondary school education, both O' and A' level. Hence the key target groups were stakeholders in secondary science education, specifically science students and secondary school science teachers in both private and public schools. The research was carried out in the Kigezi region, southwestern Uganda in the districts of Kabale, Kanungu, Rukungiri, Kisoro, Rukiga and Rubanda. Qualitative and quantitative data was collected through interviews and questionnaires to establish how the alternative learning approaches impacted learners' science education experiences as well as ascertaining the general state of science education in the region. Discussions pertaining to the situation and perception of science education before, during and after the Covid-19 lockdown were held at these schools with the students independently as well as with the science teachers.

Sampling design

According to Uganda Ministry of Education statistics, there are on average about 27 schools (government and private) per district in the sub-region. The sampling frame is the list of all secondary schools within the entire sub-region. With a target student population of over 10,000, a sample size of about 375 is sufficient (Leslie, 1965; Krejcie & Morgan, 1970). In line with the objectives of this research, two schools per district were purposively sampled so as to have a proper mix of government-aided and privately owned schools per district, and to improve the reliability of our results, some schools were chosen from urban areas while others were rural schools. In total, our data was obtained from 12 schools. Four hundred thirty-five students were randomly chosen from the 12 schools in the six districts. This sample size is large enough to ensure that the anticipated inferential tests such as t-tests or ANOVA, at 0.05 significance level, have strong power of test (Sink & Mvududu, 2010).

Data analysis

Inferential tests such as ANOVA as well as multiple regression analysis were then used to study the interdependencies among the data and the respective inference of such results to the whole population of science education stakeholders in the Kigezi region. Multiple regression was the appropriate tool to use to establish the relationship between different independent variables and the dependent variable and multiple regression shows how each independent variable is related to the dependent variable (Petchko, 2018). In this research, we used the P-value or significance probability at a 5% level so that whenever a P-value less than 0.05 is obtained, we conclude that the results are statistically significant while $P > 0.05$ was interpreted as not as significant. In statistics, the (R Square) value is used to determine the level of variance between the dependent variable and the independent variable(s). When more than one independent variable is used, or when the data sample is small, the Adjusted R-squared value is preferred as it controls over-estimates of the population results from small data samples (Reisinger, 1997). We considered a model to be good if the Adjusted R-squared value was at least 0.5% and significant or strong if it was at least 0.8.

Results

Students were asked to choose one science subject out of the five and rate it on a scale of 1–5, with 1 representing the lowest mark and 5 the highest on aspects of syllabus coverage, conduct of practicals, likability (how well they liked the subject), their confidence in passing school assessments and UNEB examinations before, during and after the lockdown. Likability of the subjects was included for two reasons: the first reason is that it could have influenced the levels of respondents' satisfaction with the various alternative learning approaches that were adopted during and after the lockdown to aid the learning process. As noted by Feistauer and Richter (2018), likability of a teacher and students' interest in a subject have a tendency to bias students' responses. The second reason is that likability of subjects could have varied before and after the lockdown. This could be due to the effectiveness of the alternative approaches that were used to teach the different subjects during the lockdown and a shift in perspectives by the learners resulting from learners placing their emphasis on certain subjects depending on future career aspirations. Finally, since the performance of students in UNEB examinations greatly affects enrolment and retention in science subjects at A' level and in post-secondary institutions, we investigated the relationship between students' UNEB expectation levels and the other factors by considering it as a dependent variable.

Fifty-five students chose to rate physics, 33 students chose chemistry, 77 chose mathematics, 68 chose biology and 30 chose agriculture, and the rest of the students did not answer that question. The results are summarized in the table below:

Before the lockdown

Table 1: Summary of respondents who rated the science subjects

Chemistry Before						**Biology Before**				
Rating	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment
1	13	3	9	2	1	26	10	15	6	6
2	9	2	12	3	1	12	3	17	5	5
3	5	6	11	3	7	7	7	13	7	5
4	1	5	8	7	8	6	12	7	12	19
5	4	12	7	19	16	12	25	16	31	32
Physics						**Mathematics**				
Rating	Practicals	Likability	Syllabus Coverage	UNEB	School Assess	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment
1	26	7	18	7	3	19	8	19	10	7
2	7	10	13	4	1	6	8	15	7	9
3	9	5	10	9	4	6	19	15	4	11
4	2	7	6	7	3	4	6	10	17	21
5	11	20	10	26	12	11	30	15	36	25

Agriculture					
Rating	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment
1	14	4	3	2	2
2	3	6	10	4	2
3	2	6	7	4	10
4	5	3	5	10	12
5	5	8	5	9	3

Physics

Likability vs practical coverage: There was a negative Adjusted R-squared Value and a high standard error, which indicates that practical coverage was not a deciding factor in likability of physics before the lockdown or that the model suggesting that likability of the subject depends on how much practical work is given should be rejected.

Confidence in passing UNEB vs practical coverage, syllabus coverage: Regression analysis showed a negative Adjusted R-squared value, a standard error of 10.1 and a high P-value of 0.97, all of which indicate that practicals are not the only determinants of students' confidence in passing UNEB and the model should be rejected. Similar results were obtained when confidence in passing UNEB was tested against syllabus coverage. Therefore, none of the usual reasons given, when taken as single independent variables, determine students' confidence in passing national examination. Even when combined, practical coverage and syllabus coverage, as the only independent variables, generated negative adjusted R-squared values, an indication that the model is false. Hence, contrary to popular belief, there is more to students' failure in physics national examinations than just poor syllabus coverage and inadequate number of practicals. We, therefore, explored further to determine any other factors that might be at play.

UNEB vs subject likability: There was a positive Adjusted R-squared value of 0.685 (standard error of 4.94) and a P-value of 0.053. Furthermore, the slope was determined to be 1.29, and all these indicate a positive relationship between students' confidence in passing UNEB examinations and how much they like the subject. However, if only 68% of students' confidence is attributed to likability, there must be other factors that decide confidence.

Confidence in passing UNEB examinations vs confidence in passing school assessments: This proved to be the single most influential factor in students' confidence in passing national examinations before the lockdown, with regression analysis giving an adjusted R-squared value of 0.996, a small standard error of 0.578 and a positive slope of 2.05, all indicating that students who were confident in their ability to pass school assessments also had high hopes of passing national examinations.

We note that when the two factors (likability and confidence in passing school assessments) were combined as independent variables, the best model was obtained with an adjusted R-squared value of 0.9991 (standard error of 0.26, positive gradients of 1.88 in the case of school assessments and 0.146 for subject likability). This indicates that 99.9% of variability in students' confidence in passing national examinations can be attributed to these two factors combined. Furthermore, a P-value of 0.0009 for school assessment and 0.07 for likability indicate that school assessments play a big role in shaping students' confidence in passing the subject.

Biology

Likability vs practical coverage: It is often claimed that doing more practicals improves students' likability of the subject. Using likability as the dependent variable and practical coverage as the independent variable, regression analysis showed that before the lockdown practical coverage by itself was not the deciding factor in likability of biology. Indeed, the Adjusted R-squared value was negative, the standard error was high at 9.61, the slope was very small and negative (-0.005) and the P-value was high at 0.99, all indicating that there was no relationship between practical coverage and likability of biology.

Confidence in passing UNEB vs practical coverage, syllabus coverage: There was no relationship between confidence in passing national examinations and practical coverage. The adjusted R-squared value was negative and the standard error was high at 12.3, indicating high variability in the answers given, and a high P-value of 0.78 indicates that we should reject the hypothesis that practical coverage alone determines students' confidence in passing examinations. Likewise, there was no relationship between students' confidence in passing national examinations and syllabus coverage (negative R-squared value). Even when the two variables were taken as both being independent variables, we did not get better results. Therefore, practicals and syllabus coverage are not the deciding factors in students' confidence in passing national examinations.

UNEB vs subject likability: Subject likability plays a very crucial part in students' confidence in passing UNEB examinations, and it was the biggest contributor to students' confidence. Here, over 90.1% of their confidence can be attributed to how well they liked the subject (P-value = 0.009 < 0.05). However, their confidence is also strongly correlated with confidence in passing school assessments (with Adjusted R-squared value of 89.5% and a P-value of 0.01). The best model was, however, obtained when practicals, syllabus coverage and likability of the subject were taken as independent variables, with 97% of students' confidence attributed to these three factors. The standard error was 1.87.

Mathematics

This produced surprising results in that it is the only subject considered where there is no single factor that determines students' confidence in passing national examinations before the lockdown. Since there are no practicals conducted in the traditional sense, it should be taken that students who chose to rate the subject in this regard interpreted "practical" as revision, where they were actively involved through personally solving equations.

Confidence in passing UNEB examinations vs practical: There was no meaningful relationship between the two variables since the adjusted R-squared value was negative, the standard error was 14.7 and the P-value was very high at 0.8. Therefore, students felt that practice alone could not determine their success in the national examinations.

Confidence in passing UNEB examinations vs syllabus coverage: There was no meaningful relationship between the two variables since the adjusted R-squared value was negative.

UNEB vs likability: There is a weak positive relationship between the two values with a low adjusted R Square value (0.242), a high standard error of 11.14, indicating high variability in the data, a small positive slope and a high P-value (0.228), which indicates that it is not the only factor determining students' confidence in passing national examinations.

UNEB vs school assessment: There was a positive relationship between the two factors (adjusted R-squared value of 0.680, standard error of 72.4, a positive gradient of 1.4 but with a slightly high

P-value of 0.053). This indicates that as students engage more with school assessments with well-planned revision sessions, their confidence grows, thus improving their chances of passing the national examinations.

Although 68% of their confidence in passing national examinations can be attributed to their confidence in passing school assessments, we cannot conclude that this is the only factor (due to the high P-value greater than 0.05). So, we experimented with a combination of factors using multiple regression and found that practicals, likability and confidence in passing school assessments can account for up to 77.9% of their confidence in passing UNEB; but the best model is obtained through a combination of confidence in passing school assessments, practicals and syllabus coverage which, when combined, can account for up to 85.6% of their confidence. However, the best model shows that confidence in UNEB is determined by their confidence in passing school assessments coupled with syllabus coverage (Adjusted R-squared value of 92.1%, standard error of 3.59). Therefore, teachers should endeavor to cover adequate amounts of the syllabus and aim to improve the students' mathematical abilities overall by raising confidence levels in passing school assessments and devising strategies to help revise the content.

Agriculture

Confidence in passing UNEB vs syllabus coverage; practical coverage; and students' confidence in passing school assessments: There was a very weak negative relationship between syllabus coverage, practical coverage and students' confidence in passing UNEB examinations. This is surprising, considering that one would expect that the more the hands-on practice, the more exposed students would become and hence increase their confidence in passing the subject.

UNEB vs likability: There was no meaningful relationship between the two variables (Adjusted R-squared value of -0.33, standard error of 4.02 and a P-value of $0.9 >> 0.05$), which indicates that students' responses regarding confidence in passing the examinations was not attributed to how well they liked the subject.

From the data, there were no clear results indicating students' confidence in passing examinations in this subject before the lockdown. Most combinations resulted in negative values, which were then rejected because they made no sense. This may suggest that more information is needed. There was, however, one relationship from the data that seemed to make sense, although the results were still weak, as shown below.

Chemistry

Practical coverage vs syllabus coverage: There was no meaningful relationship between the two variables, with negative adjusted R-squared and high P-values. Hence, these results show that there were other factors that determined the number of practical sessions students had other than syllabus coverage alone.

Likability vs practical coverage: It is often claimed that with more practical sessions organised, the most likable a science subject becomes. However, our data and analysis indicated that this is not true. The relationship between likability (the dependent variable) and practical coverage is weak at best, with an adjusted R-squared value of 0.051 and a high P-value of 3.8 and a negative slope, suggesting that there are other factors at play besides practicals.

Confidence in passing UNEB examinations vs likability: There was a positive relationship between the two variables and the Adjusted R-squared value of 0.809 (standard error of 3.1, slope of 1.68 and a P-value of $0.02 < 0.05$), which suggests that likability of the subject could not be discarded as a

factor influencing students' confidence in passing the subject in examinations. Another combination of factors with positive responses includes likability, practical coverage and confidence in passing school assessments, with this combination giving an adjusted R-squared value of 0.87, standard error of 2.5. This suggests that before the lockdown, students' confidence in passing national examinations depended on likability, practical coverage as well as their confidence in passing school assessments.

After the lockdown

Table 2: Students' rating of science subjects after the lockdown

Chemistry						Biology				
Rating	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment
1	4	4	5	2	1	9	8	7	9	11
2	12	7	14	6	7	15	5	13	7	6
3	4	6	9	5	5	16	9	15	10	17
4	5	1	12	5	9	13	16	18	17	17
5	6	11	7	15	11	10	21	15	20	16
Physics						**Mathematics**				
Rating	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment
1	7	8	7	5	2	9	8	10	6	9
2	12	1	11	4	5	8	10	11	3	4
3	9	12	11	12	5	7	7	14	11	11
4	5	10	16	6	6	6	8	11	16	17
5	20	18	12	26	6	15	34	23	40	36
Agriculture										
Rating	Practicals	Likability	Syllabus Coverage	UNEB	School Assessment					
1	7	3	1	0	0					
2	6	3	6	1	4					
3	5	4	6	4	5					
4	4	6	7	6	9					
5	6	11	10	12	10					

In Table 3, we show a summary of some of the multiple regression results obtained. Here, only the best model results are shown.

Table 3: Summary of some regression results

Chemistry			Physics			Biology		
R-squared	0.9984		0.9978			0.9999		
Adjusted R-squared	0.9938		0.9911			0.9996		
Standard error	0.3877		0.8654			0.109		
	Slope	**P-value**		**slope**	**P-value**		**slope**	**P-value**
Syllabus coverage	-0.40	0.10	Practicals	0.843	0.065	Practicals	-0.464	0.092
Likability	0.60	0.07	Likability	0.895	0.520	Syllabus coverage	0.453	0.074
School assessment	0.97	0.04	School assessment	0.273	0.057	Likability	0.609	0.034

Physics

UNEB vs practical coverage: There was a positive relationship between students' confidence in passing UNEB and the number of practicals given. This was indicated by the positive slope, a positive adjusted R-squared value of 0.597 and a standard error of 5.81, suggesting that 59.7% of the variability in students' confidence can be attributed to the number of practicals conducted. However, the P-value is bigger than 0.05, indicating that there are other factors at play.

UNEB vs likability: Analysis showed that the most significant factors affecting students' confidence in passing national examinations include likability, practicals and syllabus coverage (with 98.7% of the confidence attributed to this combination, at a standard error of 1.04). Practical coverage, confidence in passing school assessments and likability (with 99% of the variability in their confidence attributed to these factors, at a standard error of 0.87) were the most important factors and they provided the best model to explain students' confidence in passing UNEB examinations.

UNEB vs syllabus coverage: Furthermore, using syllabus coverage alone as the independent variable does not yield good results. Indeed, the adjusted R-squared value is negative, indicating that this is not a good model. The best model is therefore obtained when likability of the subject is taken into consideration along with the amount of practical work and syllabus coverage given to students.

Chemistry

Confidence in passing UNEB examinations vs likability: There was a positive relationship between the two variables but it became weaker, with only 52.6% of the confidence attributed to how well the subject is liked (at a standard error of 3.4). A P-value of 0.1 indicates that likability was not the only important factor. However, likability of the subject, confidence in passing school assessment and syllabus coverage provided the best model with an adjusted R-squared value of 0.994, a standard error of only 0.3877 and a small P-value for school assessment (0.04), indicating that this cannot be discarded as an independent variable.

Confidence in passing UNEB examinations vs syllabus coverage and practical coverage: There was no meaningful relationship between the two independent variables and the dependent variable since a negative adjusted R-squared value is obtained. This indicates that even after the lockdown was lifted, students' confidence in passing national examinations was not determined by syllabus and practical coverage but by other factors.

Mathematics

Considering confidence in passing UNEB examinations and using each of the other four variables as independent variables resulted in positive adjusted R-squared values, indicating that all the four factors are needed (to varying degrees), but the best model involves confidence in school assessments, syllabus coverage and the amount of practice students have (adjusted R-squared of 0.996, standard error of 0.930). However, likability, syllabus coverage and confidence in passing school assessments present a good model with adjusted R-squared values of 0.993.

Biology

Confidence in passing UNEB examinations vs syllabus coverage: It was shown that there is a very weak positive relationship between students' confidence in passing UNEB and syllabus coverage,with only 11.5% (from an adjusted R-squared value of 0.115 and a standard error of 5.3) of the variability in confidence attributed to syllabus coverage. This suggests that covering the syllabus alone may not be enough to get students to pass the national examinations and continue with life sciences.

Confidence in passing UNEB examinations vs likability and syllabus coverage: Multiple regression analysis showed that the best model involves practical coverage, likability and syllabus coverage (adjusted R-squared of 0.9996 with a standard error of 0.11). However, covering enough syllabus, raising students' confidence in passing school assessments as well as improving likability of the subject also provide a good basis for raising students' confidence in passing UNEB, with an adjusted R-squared value of 0.983 and a standard error of 0.74.

Agriculture

Regression analysis showed that there was no meaningful relationship between practical coverage and students' confidence in passing UNEB examinations (negative R square valued obtained) and, similarly, a positive relationship exists between syllabus coverage as the sole independent variable and confidence in national examinations. Indeed, with an adjusted R-squared value of 0.682, 68.2% of variability in students' confidence can be attributed to the amount of syllabus covered (the standard error was 2.7).

Confidence in passing UNEB examinations vs school assessments: One would expect students to feel more confident in passing national examinations if they are confident in passing school examinations. This was confirmed by the analysis, with an adjusted R-squared value is 0.7403 (with a standard error of 2.4 and a P-value of $0.04 < 0.05$). The P-value specifically indicates that the independent variable cannot be discarded as a valid determinant. The model may be improved by not just considering school assessments but also adding practicals (two independent variables). This gives an adjusted R-squared value of 0.845 (standard error of 1.879), with positive gradients for both variables reflecting a positive relationship with the dependent variable.

Confidence in passing UNEB examinations vs likability: The strongest factor that affected students' confidence in passing national examinations in agriculture is likability. With an adjusted R-squared value of 0.942 (standard error of 1.147), students were more likely to report being confident with regard to the examination if they liked agriculture and the P-value of 0.0039 suggests that likability cannot be ignored. Finally, students who reported liking the subject and had done some practicals reported being more confident about passing UNEB examinations, with an adjusted R-squared value of 0.974 (standard error of 0.773).

Discussion of Results

This research shows that before and after the lockdown, there was no relationship between the number of practicals done and syllabus coverage. We also note that several students complained (in the comment section of the questionnaires) about the lack of practical time, with most of the catch-up time being dedicated to theory. According to Zengele and Alemayehu (2016) and Shah (2020), hands-on practice helps students to improve retention of knowledge and to deepen understanding of abstract theoretical concepts, besides improving their cognitive abilities as well as independent learning. In addition, Lupupa and Aubriel (2020) and Basheer, Hugerat, Kortam and Hofstein (2017) showed that there was significant improvement in students' test scores when demonstrations were used to teach concepts in chemistry (like oxidation reactions). Furthermore, Meyer, Schmidt, Nozawa and Paneee (2003) note that demonstrations encourage students to be more inquisitive, makes them more active and hence enhancing their learning. This point is supported by Augusto, Castelo-Grande and Estevez (2019), who observe that students' performance in engineering is affected by passive learning and excessive theoretical deductions. They further note that laboratory work enables students to develop a range of skills like analytical skills, teamwork, drawing conclusions and problem formulation, among others. Daluba (2013) notes that students' perception of agricultural science is affected by inadequate teaching approaches, which result in limited interest and poor performance. He suggested that interest and curiosity can be improved by the use of learning activities that are stimulating to the students, demonstrations and generally making classrooms student-centred. Despite the advances in technology and the subsequent changes that have taken place in education, the nature of laboratory and practical work in general is transforming slowly. This is because the technology that can transform face-to-face learning into laboratory exercises that are interactive is "complex and requires a multi-step approach" (Gasparello et al., 2022). Bhute, Inguva, Shah and Brechtelsbauer (2021) and Patterson (2011) argue that it is necessary to transform traditional laboratories to enable remote practical experimentation and learning. Patterson (2011) further urges incorporating multimedia laboratory manuals to help students with preparation for practical work, which makes laboratory tasks as well as report writing easier. He argues that even just making good quality videos of laboratory equipment, instructions and assembly of the experiment help students to contextualise and make learning more meaningful. These studies suggest that when laboratory practical work and demonstrations are well planned, they have the potential to improve students' performance. Our research, however, suggests that students' confidence in passing national examinations cannot be based on practical coverage alone, but on a combination of factors.

Likability of the subjects had a positive relationship with students' confidence for all the subjects before the lockdown (with the exception of agriculture, where there was no relationship at all between likability and confidence in passing examinations), but the results showed that this factor alone could only provide a moderate relationship with performance, except for biology where likability strongly determined students' confidence in national examinations. Of all the four subjects, mathematics had the weakest relationship between likability and confidence in passing examinations. After the lockdown, the strong relationship between likability and national examinations only got stronger for biology, and in mathematics, students tended to be more confident in passing national examinations if they reported liking the subject (likability could not be ignored anymore as was the case before the lockdown). This was the same for agriculture, where confidence was significantly high when practical coverage and likability were combined. Therefore, practical work, when combined with students' liking of a science subject as well as healthy syllabus coverage, can improve confidence

in students, which may then result in improved test scores; and this was clearly demonstrated in the analysis before and after the lockdown.

These results indicate that in order for students to have confidence in their abilities and to ultimately pass examinations, educators need to work on the affective part of their subjects by providing motivation rooted in students' reality, for the different topics in their subjects. It has been noted by the Australian Education Review of 2007 that "science education is too heavily skewed towards the abstract conceptual canon of science, and too often ignores the realities of students' own lives, interests and feelings" (Tytler, 2007). Parents and teachers, therefore, have a challenge to entice students with science and improve likability for the subjects. The other explanation can be derived from Kabunga et al. (2016), who note that students with a poor attitude to science subjects tend to perform poorly and students who are motivated in science tend to perform well in assessments. If students' attitude is poor, they are less likely to be confident in passing the national examination and this, in part, is what our model shows. Therefore, for students to pass science subjects, substantial effort must be made towards improving their attitudes by popularising them (Uganda National Commission for UNESCO, 2017). Michaelis (2017) notes that the process of motivating learners is complex and may involve targeting students' intelligence beliefs as well as their intrinsic motivation (internal desire). Intrinsic motivation may be provided by parents, teachers and the government through the Ministry of Education in a variety of ways, one of which may include alignment of what teachers teach with real life, using examples and textbooks with Ugandan illustrations to provide cultural and geographical contexts, which were determined to be very important in aiding students' understanding (Jimes, Weiss, & Keep, 2013). By doing this, students feel that learning science subjects has meaning in their lives, thus raising their level of motivation and likability.

For subjects like mathematics and chemistry, confidence in school assessments and syllabus coverage, when combined with practice (for mathematics) or likability (for chemistry), provided strong relationships with national examinations. For both subjects, school assessments were an important factor before and after the lockdown, but practical coverage was more important to students of chemistry before the lockdown than syllabus coverage. These suggest that students need continuous assessment more in these subjects, which then is used to check their understanding and improve performance. School assessments are both formative and summative in nature (Sanchez-Luiz et al., 2021), but the ultimate goal is to see that students acquire the learning objectives intended and ultimately pass national examinations, which then ensure their continued journey with STEM subjects and careers. UNEB examinations are summative in nature and do not offer students an opportunity to improve their result. Continuous assessment then takes on the role of formative assessment in that it informs and helps in monitoring the learning process. However, to be effective, teachers are required to give timely feedback to their students, their parents and school administrators (Muskin, 2017), and when given in an informative manner, such results benefit students through enabling them to improve their learning by addressing problems that may have been identified by the teacher. In mathematics and physics, topics tend to be hierarchical in nature, meaning that topics can be arranged in a given order (like a tree) with topics at the root affecting other topics that come after. Basing on this, Sánchez-Ruiz, Moll-López, Moraño-Fernández and Roselló (2021) propose that continuous assessment in mathematics should be based on such organisation and each assessment task be based on one topic and its immediate successor to gauge improvement in the previous topic and its application to the current topic. Not only do school assessments help students, but they are also of great help to teachers as they inform them of areas that may need special attention (what to

repeat, revise or add), as well as giving them a chance to modify their teaching methods (Sanchez-Luiz et al., 2021; Muskin, 2017; Wickramasinghe & Timpson, 2006). Feedback should go beyond a number or grade but should provide adequate details to enable the student to address issues and challenges (Walde, 2016). However, it is argued that continuous assessment can be shallow and promote superficial learning (Sanchez-Luiz et al., 2021). Muskin (2017) argues that continuous assessment should not contain just traditional exercises and problem solving, but also project work to foster the development of higher-order skills, inquisition and interest.

There was a negative correlation between likability of science subjects and practicals. This suggests that even when practicals are carried out, they are mostly done to clarify content from the theory part of the course and not meant to improve students' engagement and likability of the subject. This is in agreement with Ghartley-Ampiah at al.'s (2004) discovery that teachers in Ghana tended to focus on clarification of theory in their practical work and not on attitude. There is a need to incorporate everyday life into the practical component, for this helps students not only visualise their ideas but also generate new ones, with the overall effect of driving up excitement for science subjects. This will ultimately not only improve achievement in national examinations, but also lead to increased retention and higher numbers in STEM fields. Perhaps the best way to ensure an attitude change is to use science to solve societal problems, even at the classroom level (Galvao et al. 2010), thus making it relevant.

Conclusion

We have seen that although practicals and good syllabus coverage are important for students' confidence in passing examinations, likability of the subjects plays a big role in students' passing and progression in the sciences. This result is also supported by Musasia, Ocholla and Sakwa (2016), who recorded students' low interest and lack of motivation and the poor performance in science subjects in secondary schools in Kenya. This research has provided evidence that, indeed, likability and pass rates are related and that in order to boost retention and recruitment rates in STEM, more has to be done to make the subjects likable.

We have also noted that there is no relationship between the number of practicals done and syllabus coverage. This confirms previous claims by several researchers that students are not doing enough practical work, which is critical to the acquisition of scientific skills. A drastic improvement in the availability of standard laboratories and ensuring that teachers conduct timely practicals for the students is recommended.

Other recommendations include the use of technology to aid the learning process (Ouma, 2021; Adams, 2009; Gasparello et al., 2022). It should be noted that students generally like and use technology to stay connected. Over 50% of students involved in this research indicated having a smartphone. Steps should, therefore, be used to incorporate this in the teaching and learning of sciences, for example by running practical demonstrations and streaming them over the internet to students' phones.

Limitations

Data for this research was collected in February 2022. Some of the respondents had just started Senior 5 and, thus, they may not have studied enough to provide a realistic response regarding their future performance in national examinations. They may have used their past experience with the subjects and their past UNEB examination performance to inform future performance. Furthermore, with

UNEB examinations at least 18 months away for students in Senior 3 and 5, these respondents may not have had to seriously ponder their expected UNEB performance until it was presented to them in the questionnaire, and this may have affected some responses.

In future, we intend to implement an intervention plan involving setting up a digital center to enable teachers to provide learning materials that students can access, with a well-stocked laboratory. There is also a need to reconsider teacher education to ensure that teachers have the expertise necessary for successful learning, and to provide support for the already serving teachers, many of whom have gone through traditional methods of teaching and need help and support to transform their teaching to embrace and incorporate digital tools not just in the classroom but in the laboratory, too.

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