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Growth Mindset Interventions Catapulting High Scores in Chemistry among Low-Socioeconomic Status Learners in Chipata District

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Abstract

Students from low socioeconomic status families are not a stranger to problems that plague the province and the district especially in education. Majority of them struggle to excel in their schooling in secondary education due to bad performance in science related subjects like chemistry. The reason being that they entertain the idea that these subjects are meant for the born intelligent and they cannot improve in them no matter how hard they try to work on improving them. They approach them with no academic diligence, feel lost in the school environment, lack motivation and feel marginalized. As a result, they perform badly. Their counterparts from high socioeconomic status families have no problems with their scores in chemistry and other science subjects. This gap needs to be closed and growth mindset as a theory has gained traction over the years. The extent to which students view their intelligence as improvable (i.e., their "mindset") influences students' thoughts, behaviors, and ultimately their academic success. Thus, understanding the development of students' mindsets is of great interest to education scholars working to understand and promote student success. Carol Susan Dweck, an American Psychologist, gives two theories of intelligence, the theory of fixed intelligence and the theory of malleable intelligence. Pupils who believe their intellect is innate and unchangeable hold an 'entity' view of intelligence, more commonly known as a 'fixed mindset'. On the other hand, those who have a 'growth mindset' believe their intelligence is changeable and can develop over time through practice, effort and instruction (David S Yeager, Gregory M Walton and , 2011). This is also known as 'incremental' theory. Dweck notes that individuals with a growth mindset often attribute their performance to the effort they put into their work, rather than factors out of their control such as luck (Cohen G. L., et. al, 2006). This investigation was to experimentally test whether social-psychological interventions like the growth mindset intervention can improve the chemistry achievement of learners from low-income families of Chipata district of Zambia. In this research, we developed and tested if a growth mindset intervention could be of influence to augment academic outcomes in chemistry. We subjected 138 students from different day secondary school in low-income compounds dotted around Chipata district in Eastern province. The sample size of the study was determined by the total number of day schools in Chipata district, which 27. In order to determine this sample for the study, the researcher used the schools' grade 11 registers as a sampling frame that includes a good population representation of the day schools. A simple random sampling was used in order to give every element an equal chance of being selected. In the same vein, the choice of the sampling design increased the validity and reliability of the results. The sample was taken from three different day schools of Chipata district. These are Damn View, Lutembwe and St Atanazio Day Secondary Schools in Damn View, Lutembwe and Mchini compounds respectively. The 12 discussants for the one Focus Group Discussion (FGD) were selected from the named schools. The study revealed that students tended to shift

towards viewing intelligence as fixed to malleable i.e., to those of the view that one is born intelligent and there are no two ways about it and those holding the view that with practice, effort, persistence, resilience and instruction, one's intelligence changes, it is like the muscle elasticity. When chemistry scores are compared both in the pretest and posttest, there is no slightest doubt that the grades have swung on the improvement side of the academic pendulum. In a summation, the average scores are 56.3 and 62.2 in the pretest and posttest respectively and the average difference is 5.9. The intervention worked despite its limitations.

Keywords: Intelligence, Growth Mindset, Fixed Mindset, Persistence, Resilience, Effort, Challenge Seeking Behavior

Introduction

Methods

The investigation used both quantitative and qualitative methods which include quantitative studies using a survey methodology and Focus Group discussion.

The sample size of the study was determined by the total number of day schools in Chipata district. This is to reduce sampling errors as well as other errors related to sampling. We have 27 day secondary schools in the district, with a total of 3, 210 grade 11 learners. We selected 3 out of 27 day schools, with a population of 425 G11 learners. Out of these the participants were 138.

Study Setting: The study was conducted on a district scale in day secondary schools dotted around low-income compounds namely, Mchini, Navutika, Magazine, Ferendum, and Munga. The sample was taken from three different day schools of Chipata district. These are Dam view (53 G11 pupils), Lutembwe (38 pupils) and St Atanazio (47 pupils) Day Secondary Schools. These schools are located in Dam view, Lutembwe and Mchini compounds of Chipata respectively.

Study Design and Population: We conducted a cross-sectional and descriptive study from 8th February to the 30th of March 2023 to investigate whether a Growth Mindset Intervention-belief that one's intelligence is malleable and can grow- can improve the learners' motivation and achievement in Chemistry.

The sample size of the study was determined by the total number of day schools in Chipata district. This is to reduce sampling errors as well as other errors related to sampling. We have 27-day secondary schools in the district, with a total of 3, 210 grade 11 learners. We selected 3 out of 27-day schools, with a population of 425 G11 learners. Out of these the participants were 138.

Sampling and Data Collection: The sample size of the study was determined by the total number of day schools in Chipata district. This is to reduce sampling errors as well as other errors related to sampling. We have 27 day secondary schools in the district, with a total of 3, 210 grade 11 learners. We selected 3 out of 27 day schools, with a population of 425 G11 learners. Out of these the participants were 138.

In order to determine an ideal sample for the study, the researcher used a sampling frame that includes a good population representation of the day schools. A simple random sampling was used in order to give every element an equal chance of being selected. In the same vein, the choice of the sampling design increased the validity and reliability of the results. This is the result of the use of scientific sampling method which gives each element in the study population an equal but non zero chance of being included in the sample.

The figure below shows Sex as a socio-Demography of our participants.

Figure 1: Sex as a Socio-Demography of the Participants in the study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**Female**	73	52.90	52.90	52.90
	Male	65	47.10	47.10	47.10
	Total	**138**	**100.0**	**100.0**	**100.0**

Ethical Considerations: Administrative authorizations (DEBS, Head Teachers, laboratory In-charge) were obtained. Ethical clearance was obtained from the local campus DMI university ethics committee for human research. Informed consent was also obtained from study participants and their personal information has been kept confidential.

Statistical Analysis: At the end of data collection, questionnaires were sorted out to check for errors and any missing information. Quantitative data was entered and analyzed in excel while the researcher used thematic analysis for qualitative data from the FGD. Some variables were recoded to facilitate analysis. We used descriptive statistics in the form of proportions (%) for categorical data. With the help of excel, the data was then represented in tables, graphs, pie charts which was used to facilitate the interpretations. Interpretation of data was done in Microsoft word after importing data from excel.

Results

Growth Mindset

In measuring of growth mindset pre and posttest**,** 138 pupils' responded to four measuring instruments with 5 closed responses. Their average scores per question were recorded and the total group score is alls recorded as the table below shows.

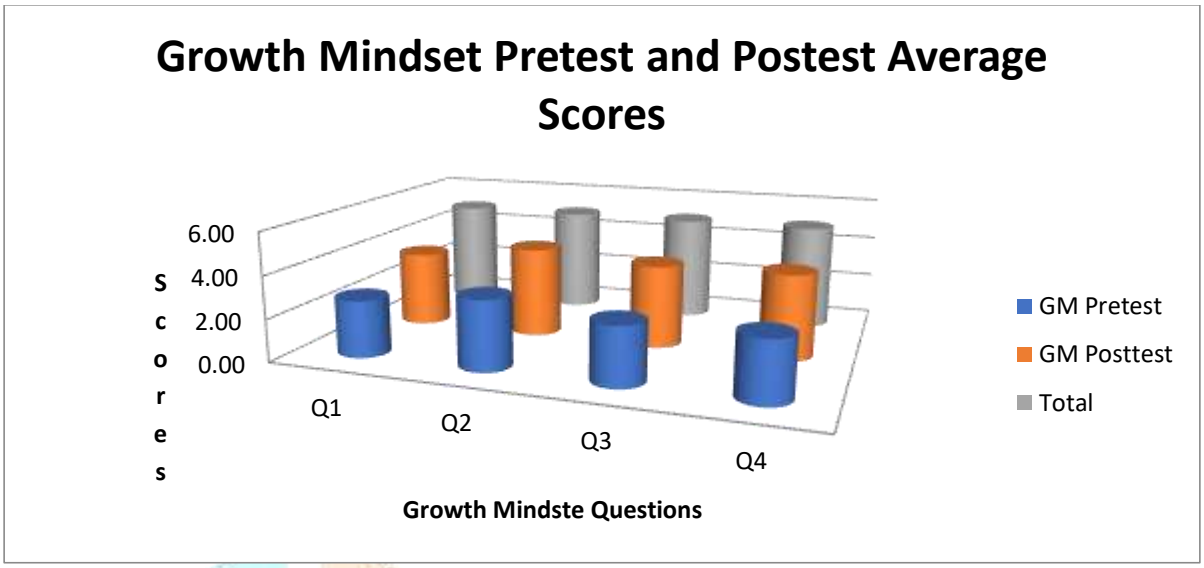
Table 1: Growth Mindset Average Results

Total	Q1	Q2	Q3	Q4	Total
GM Pretest	2.68	3.29	2.76	2.84	11.57
GM Posttest	3.57	4.25	3.90	4.01	15.72
Total	5	5	5	5	20.00

As shown above, their average scores were lower in the pretest than in the posttest. In question 1 their average pretest score was 2.68 and their posttest score was 3.57 out of 5. In question 2 their average score rose from 3.29 to 4.25. In question 3 it rose from 2.76 to 3.90. Similarly, in question 4 it rose from 2.84 to 4.01. Consequently, there was a rise in their total average score from 11.57 to 15.72 out of 20.

The graph below best illustrates the results.

Figure 2: Growth Mindset Results



Academic Behavior

136 pupils were asked to respond to the 15 instruments measuring their academic behavior. And the following were the results of the pre and posttest results.

Table 2: Average Academic Behavior Results

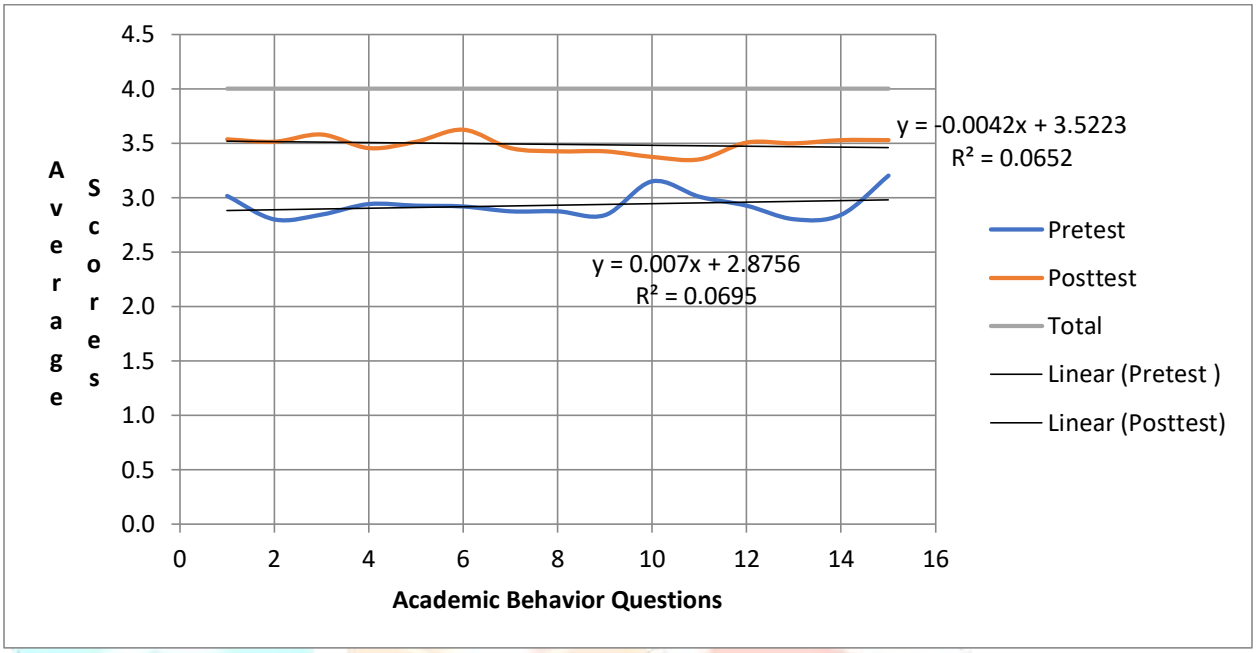
Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Total
Pretest	3.0	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.8	3.1	3.0	2.9	2.8	2.8	3.2	44.0
Posttest	3.5	3.5	3.6	3.5	3.5	3.6	3.5	3.4	3.4	3.4	3.4	3.5	3.5	3.5	3.5	52.3
Total	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	60

The average scores of our learners show a rise in all the questions: 3.0 to 3.5 in question1; 2.8 to 3.5 in question2; 2.8 to 3.6 in question3; 2.9 to 3.5 in question 4; 2.9 to 3.5 in question 5; 2.9 to 3.6 in question 6; 2.9 to 3.5 in question 7; 2.9 to 3.4 in question 8; 2.8 to 3.4 in question 9; 3.1 to 3.4 in question 10; 3.0 to 3.4 in question11; 2.9 to 3.5 in question 12; 2.8 to 3.5 in question 13; 2.8 to 3.5 in question 14 and 3.2 to 3.5 in question 15.

The average score of the learners in the pretest is 2.88 out of 4 per question. And their average total score for all the 15 questions is 44.0. In the posttest, their average score per question is 3.52 out of 4 and their total average score is 52.3 out of 60.

The figure below best illustrates these results.

Figure 3: Academic Behavior Results



Chemistry Scores

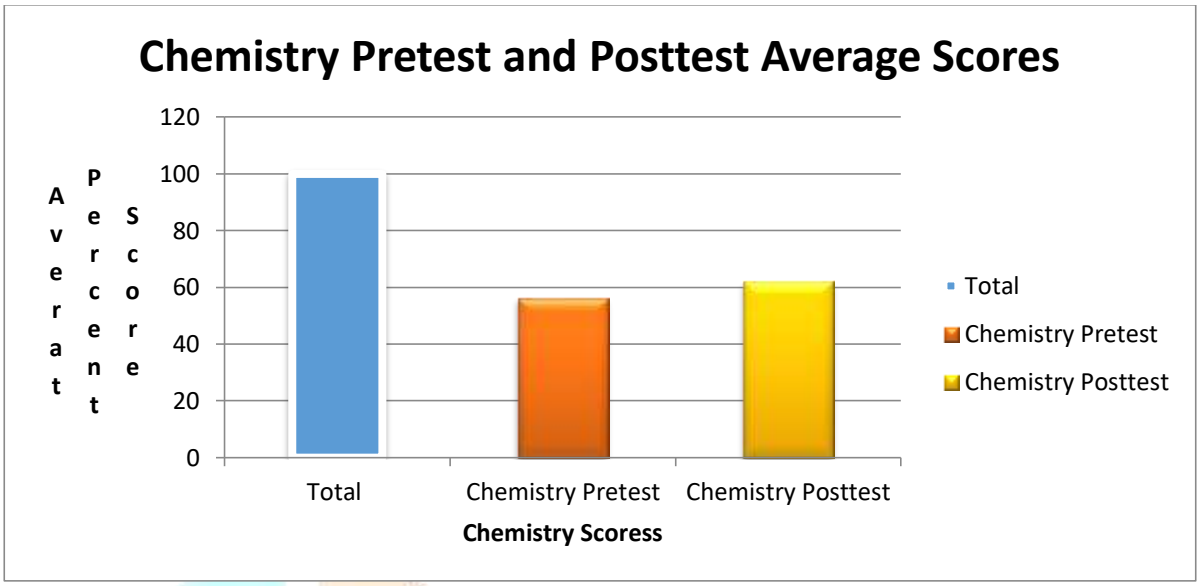
Here are both the pretest and posttest scores attained in chemistry for the 138 pupils as well as the variance in scores.

Table 3: Chemistry Results

Total	
Chemistry Pretest	56.32 %
Chemistry Posttest	62.15 %
Variance	5.9 %
Total	100

In the pretest, our pupils had an average score of **56.3** percent. After the intervention, in the posttest, our pupils scored an average score of **62.2** percent. The mean score improved by **5.9 percent**, from **56.3%** to **62.2 %.** The results emphatically attest to the progress between the pretest and posttest of our learners.

Figure 4: Chemistry Pretest and Posttest Average Scores



Discussion

Growth Mindset

Before the pupils were exposed to the intervention the outcome of their responses to the statement that ***One can learn new things but cannot make oneself smarter*** were the following: 16 said the statement is not at all correct, 10 said that the statement is a little not correct, 10 were for both, 5 said it was a little correct and 97 said that the statement that was a lot correct. After the intervention, the responses were as follows: 88(63.77 percent) said that the statement was not at all correct, 27(19.57 percent) A little not correct, 0 for both, 15(10.87 percent) A lot correct and 5.80 percent) a lot correct. You notice a swing from a lot correct to not at all correct, exemplifying that the growth mindset intervention worked wonders on these pupils for they learnt during the intervention that their minds are not fixed and their brain has some elasticity like that of the muscle which can be changed and so their intelligence can be worked out and that they can be smarter.

Prior to being subjected to the growth mindset intervention, the pupils were asked to respond to the statement that ***you cannot change how intelligent you are*** and the following were their responses: Not at correct were 14, a little not correct were 15, both had 1, a little correct were 6 and a lot correct were 102. After the intervention the results were different: 107 not at all correct, 15 a little not correct, 10 a little correct and 6 a lot correct. Strikingly there is change of mind in their reaction because they now believe that one's intelligence can change given factors like persistence, effort, seeking challenging tasks and resilience among others.

The respondents had this to say about the statement ***how intelligent you are is something about you that you cannot change***, 9 said that it was not at all correct, 8 said that the statement was a little correct, 0 were for both, 7 thought the statement was a little correct and 114 said that the statement was a lot correct. After the intervention, respondents brought out their answers this way: 117 not at all correct, 8 little not correct, 7 a little correct and 6 a lot correct. There is meaningful change after the pupils have been subjected to the growth mindset intervention as can be gleaned over from the above statistics. Pupils who believe their intellect is innate and unchangeable hold an 'entity' view of intelligence and that is what we largely saw in the pretest data above.

Before being subjected to the growth mindset intervention, the pupils were pretested to furnish the research team with responses to the statement that ***people are born intelligent or not, and this cannot be changed*** and the respondents said the following: 15 said that the statement was not at correct, 10 said that the statement was a little correct, 8 were for both statements, 25 said that the statement was a little correct and 80 said that the statement was a lot correct. Afterwards, they were given a posttest on the same and their responses came

out like this: 87said that the statement was not at all correct, 30 said that it was a little not correct, 10 a little correct and 11 a lot correct. The intervention dismantled their outlook of intelligence as can be evidenced here having many of them undergo a mind shift.

Academic Behavior

In the pretest, it is clear that the pupils agreed with the statement, ***the effects of failing chemistry are bad and should be avoided,*** with high numbers of about 53 (strongly) and 45 (just Agreed) out of 136. Only 5 disagreed strongly and 33 disagreed with the statement. The picture is that failure is bad and ought to be avoided at all costs. However, in the posttest 78 strongly disagreed, 53 disagreed, 5 agreed and no one strongly agreed with the statement. The bottom line here is that after the intervention pupils have come to a realization that the effects of failure in chemistry are not bad and should not be avoided because they are part and parcel of the learning curve.

Before the intervention, pupils responded to the statement ***I believe experiencing failure in chemistry hurts my learning and growth***. 8 pupils stated that they strongly disagree, 46 disagreed, 47 agreed and 35 were in strong agreement. However, after the intervention, 7 strongly disagreed 52 disagreed, 7 agreed and 0 strongly agreed with the statement. There is an increase in the number of pupils strongly disagreeing and disagreeing from 8 and 46 at pretest to 77 and 52 respectively at posttest. This is indicative of the change in their belief system about how they should handle failure in chemistry. It has dawned on them that experiencing failure in chemistry is part of life and success does not come without difficulties and huddles. One ought to experience the "deep" in order to succeed.

In the pretest 3.68% strongly and 29.41% did not attach importance to learning, whilst 45.59% and 21.32 % respectively felt strongly agreeable and agreeable to the importance of learning. What is coming to the fore from the posttest is that no one (0) strongly disagreed and 4.41 % disagreed to the notion of attaching importance to learning and the number of those strongly agreeing has gone down from 45.59% to 33.08% and those agreeable has gone up from 21.32% in the pretest to 62.5% in the posttest. When you compare the pretest and posttest on the importance of learning, there was what can be referred to as the 'change of heart' by the pupils. They attached more importance to learning in the posttest than in the pretest owing to the effects that the intervention had on them. There is a paradigm shift in their way of looking at learning after the intervention.

The issue of putting a lot of effort into learning was handled in the following manner by the respondents: 9(6.62%) strongly did not agree with putting a lot of effort into learning, 14(10.29%) did not agree, 91(66.91%) accepted that they put a lot of effort into learning and 22(16.18%) strongly agreed to putting a lot of effort into learning. The following were 136 pupils' individual answers to the statement ***I put a lot of effort into learning***: 85(62.5%) agreed strongly with the statement, 46(33.82%) agreed, 6(4.41%) disagreed with the statement and 0 strongly disagreed with the statement. There is certainly a change statistically in the numbers between the pretest and posttest on finding out what the pupils' take was with regard to the effort they put into learning. 22(16.18 percent) agreed strongly in the pretest whereas 85(62.5 percent) strongly agreed in the posttest. While 91(66.91 percent) agreed with putting a lot of effort into learning in the pretest, 46(33.82 percent) agreed to the idea in the posttest. There was no pupil in the posttest who strongly disagreed while they were 9(6.62 percent) in the pretest and the number of those disagreeing reduced from 14(10.29 percent) in the pretest to 6(4.41 percent) in the posttest. Overall, there is change in the number of pupils in putting a lot of effort into learning.

There is an improvement in the number of pupils who said that they strongly agreed and agreed in general to liking learning chemistry as follows: In the posttest 62(45.59%) were in strong agreement 74(54.41%) were in agreement and none (0%) disagreed or strongly disagreed that they like learning chemistry. While in the pretest, 58(42.65%) agreed, 36(26.47 %) strongly agreed and 4(2.94%) strongly disagreed and 38(27.94%) disagreed.

To the statement ***I like "chemistry" and "chemistry" is personally important to me***, the pupils gave the following responses: 23 (16.91 percent) went for strongly disagree, 6(4.41 percent) chose disagree, 66 (48.53 percent) selected agree and 41 (30.15 percent) ticked on **I strongly agree.** From 41(30.15 percent) to 86(63.24 percent) is undoubtedly an increase in number of the pupils who strongly agreed to the statement, ***I like "chemistry" and "chemistry is personally important to me*** statement. This upswing is attributed to the intervention. Being part of this study has had a significant effect on their academic behavior as one would gather from the numbers. The strongly disagree 23(16.91%) in the pretest change to 4(2.94%) at posttest is a case in point of pupils' mindset changes brought about by them being a part of this study. There is evidence here that growth mindset interventions impact positively on academic behavior. 89(65.44%) were strong in agreeing that they planned to continue learning after school at posttest and 27 out of 136(19.85%) strongly agreed at pretest. This literally means that 62 pupils changed their mind and moved to strongly agreeing that they planned to continue with learning after school. They were 72(52.94%) at pretest who merely agreed to the statement plummeting to 45(38.08%) at posttest because of changing their minds to strongly agreeing with the plan to continuing with learning after school. From 30(22.06%) who disagreed during the pretest to 0 who disagreed at posttest, 7(5.15%) who were strongly disagreed at pretest coming to 2(1.47%) at posttest is a cogent argument that the mindset change is not an accident but as result of a serious growth mindset intervention at work.

An upturn from 34(25%)strongly agreed on putting a lot of effort on chemistry at pretest to 65(47.79%) at posttest, 57(41.91%) in agreement with putting a lot of effort on chemistry assignments at pretest compared to 68(50%) equally agreeing with the effort on chemistry assignments, Putting 6 (4.41%) strongly disagreeing at pretest side by side with none(0) strongly in disagreement at posttest and looking at 39(38.68%)at pretest disagreeing and 3(2.21%) is a pointer that this intervention improves academic behavior. The growth mindset intervention has melted away the rigid view of things prior held.

Change is evident in the variables strongly agree, agree, disagree and strongly disagree in terms of responses during pretest and posttest when pupils are asked to react to the statement ***I do not give up when chemistry becomes difficult***. 33(24.26%) strongly agreed at pretest becomes 62(45.58%) at posttest. 49 (36.03%) agreeing with the statement at pretest changes to 69(50.74 %) agreeing at posttest, 54(39.71 percent) disagreeing with the statement at pretest reducing to 4(2.94%) at posttest.

In pretest on pupils' reaction to the statement ***when I am handling a challenging chemistry problem, I do not give up until I find a solution*** the results were that 2 out of 136 (1.47%) were strongly disagreed to working until they solved the problem, 23 (16.91%) were not agreeable to working at arriving at a solution to the problem, 64 out of 136(47.06%) agreed that they would see to the end of the problem and 47(34.56%) were strongly agreeable that they would work all the way until the problem was unlocked.

And the posttest results indicated that 61(44.85%) said that they strongly do not give up until they find a solution to when handling a challenging chemistry problem, 72(52.94%) said that they were agreeable not to give up until they arrived at a solution when handling a challenging chemistry problem, 3(2.21%) said that they were disagreeable to not giving up when they were handling a challenging chemistry problem and those who were strongly disagreeable to not giving up until they found a solution were 0.

The posttest scenario is influenced by the intervention which has as its backdrop as trying challenging tasks and continuing working on them despite difficulties being so critical to achievement. The pupils were exposed to the interventions on perseverance, effort, resilience and challenge seeking and this intervention has no doubt impacted on the posttest picture of the pupils in terms of their responses.

3(2.21%) strongly disagreed to the statement that ***I choose to do more difficult chemistry questions instead of easy ones,*** 36 out of 136 (26.47%) disagreed with the same statement, 54 out of 136(39.71%) agreed with the statement and 43out of 136 (31.62%) agreed strongly in the pretest., while 64(47.06%) strongly agreed with the statement, 59(43.38 %) agreed with the statement, 13(9.56%) disagreed and 0 strongly agreed in the posttest.

There is a shift when you take a hard look at the pretest and the posttest in term of those who did not initially agree with the statement agreeing or those who merely agreed to strongly agreeing or dropping strongly disagreed entirely. The intervention has left an indelible mark on the pupils; they believe if one does not try difficult tasks he remains a child and does not learn much.

In the pretest respondents looked at the statement ***I love chemistry because it challenges me to think*** in terms of agreeing or not agreeing differently. 37(27.21%) strongly agreed with the statement, 60(44.12%) agreed with the statement, 29(21.32 percent) disagreed with the statement and 10(7.35%) strongly disagreed. In the posttest 56(41.81%) strongly agreed, 68(50%) agreed with the statement, 10(7.35%) disagreed and those who were strongly disagreed were 0.

Asked If after getting a disappointing grade in chemistry, they did their best to improve on the next one, the pupils had this to say: 13(9.56%) said that they strongly disagreed in doing their best to improve their grade on the next one, 33(24.26%) were not in agreement to doing their best to improve their grade on the next one, 58(42.65%) echoed that they agreed to the idea that they would do their best to improve on the next one and 32(23.53%) strongly agreed to the idea of doing their best to improve their grade on the next one.

Of those 136 who responded to the questionnaire on the question If ***I get a disappointing grade in chemistry, I do my best to improve on the next one*** 71(52.21%) said that they strongly agreed to the statement, 63(46.32%) said that they agreed with the statement, 2((1.47%) answered that they disagreed with the statement and 0 strongly disagreed with the statement.

From the data we see that there is a change numerically on the responses by the pupils intimating internalizing effort after being exposed to the growth mindset intervention and realizing that effort is an investment in learning.

In the pretest the pupils expressed how satisfied they felt about their lives as follows: 51 equating to 37.5 percent felt they were very happy, 37 standing for 27.21 percent were happy with their lives, 30 coming to 22.06 percent felt they were disappointed with their lives and 18 approximating to 13. 24 percent felt they were very disappointed with their lives. And the same in the posttest 70(51.47 percent) said that they were very happy, 64(47.06 percent) said that they were happy, 2(1.47 percent) responded that they disappointed and there was none who said that they were very disappointed.

Again, there is the change of mind in the posttest here and the numbers have improved in the posttest and paint a very positive picture about how satisfied they felt with life. The paradigm shift is obvious in this case emanating from the intervention.

A number of responses were given by the respondents regarding the ***question how close are you with your best friend?*** The responses are both for pretest and posttest. 45 representing 38.08 percent said that they were extremely close, 59 accounting for 43.38 percent said that they very close, 32 mirroring 23.53 percent said that were just close and no one, zero said that they were not close. None (0) said that they were not close, 4/136(2.94 percent) said that they were just close, 56/136(41.18 percent) said that they were very close to their best friends and 76/136(58.88 percent) said that they were extremely close. When the pretest and posttest are critically observed, there is a surge in numbers in the posttest indicating a change in responses that were initially given in the pretest. This realization stems from the intervention. It is clear that friends or peers are very important in influencing mindset change and also in academic and mastery behavior change.

When chemistry scores are compared both in the pretest and posttest, there is no slightest doubt that the grades have swung on the improvement side of the academic pendulum. In a summation, the average scores are 56.3 and 62.2 in the pretest and posttest respectively and the average difference is 5.9.

One does not need rocket science to see that growth mindset can help to change pupils' beliefs about the nature of their academic capability, providing pupils with the idea that their performance can improve with the amount of effort they put in. With this belief, pupils are more likely to engage in positive school behaviors and make an effort to succeed academically which can result in improved academic outcomes.

From FGD it is certainly important that the study was conducted because the effects are edifying in the sense that there has been mindset change in terms of looking at intelligence and academic achievement. This has unlocked the success path in the subjects that were thought to be very hard and meant for those who had

special intelligence. Given the right environment and resources the pupils think they are all competitors in chemistry and other subjects.

The Focus Group Discussion (Qualitative Results)

The presentation of data collected from participants in the Focus Group Discussion (FGD) from different selected schools held at Dam View Day secondary school in Chipata on push and pull factors of growth mindset interventions collected using a prompt list (see appendix on the push and pull factors of GMI). And since the data was qualitative in nature thematic analysis was used to analyze the data.

Participants who were part of the FGD when interviewed about how helpful the study was to them, all the 12 participants were unanimous in bringing out the fact that the study was extremely helpful to them in the sense that it opened up the whole new horizon of looking at intelligence and how the new outlook could be used as the crest of the wave in academic performance not only in chemistry but in other disciplines as well especially those perceived to be the preserve for the born naturally intelligent.

In their discussion, the participants talked of the persistence, effort, resilience and seeking challenging tasks as factors that would have an effect on their growth mindset. Feedback, Encouragement and Rewarding became topical in their discussion as what would help them cultivate the growth mindset.

They said educators who are simple, acknowledge their own struggles and mistakes, make learners feel important and encourage them to attempt are more empowering and grow the mindset as opposed to condescending boastful educators who use every effort to show that they are more educated. Apparently, failing students and telling them that the subject is tuff and needs more effort doesn't do much in growing the mindset. It only discourages learners and defeats their fragile minds.

The issue of right friends was discussed as being pertinent in impacting growth mindset and the reason that was advanced was that learning becomes easier through peers and that they exert some influence on each other that could be tapped into in impacting growth mindset.

Society was also cited as one of the crucial element in growing the mindset. Some societies are so negative to school and scholarly practices that a learner can barely relate school activities to real life experiences. To this effect, learners become stranger to school programs and learning is not meaningful. Living in communities that fosters scholarly minds and reinforce what one does at school is helpful.

Educators discussed the importance of designing lessons and curriculums that relate to everyday life of the learners. They reiterated the notion that learners are often lost in the classroom because they cannot relate what is being taught to their day to day lives. Curricula that are down to earth and educators who relate to the circumstances and situations of their learners are more successful in growing the mindset of the learners.

The discussants brought out this point emphatically that the view people hold can affect learning as was seen or witnessed before the intervention was subjected to the pupils. The majority of them did not think that intelligence could be improved through effort.

Teachers favoring those who are performing very well and name-calling the strugglers as dunderheads negatively impacts growing the minds. Instead of pushing them to work hard, it just destroys their minds and makes the give up.

Chemistry can be technical in language and so the methods used when teaching chemistry can have an effect on growth mindset. One would get discouraged and think that it is very tough and beyond his innate capacity. It can push you to think that doing better is not simply attainable. It needs more time than is usually assigned. Therefore, assigning less time to the concepts and curriculum negatively impacts the mindset growth.

The FGD also did make mention of making available text books that are couched in very simple language, full of diagrams and charts, that pupils even on their own should be able to understand. Learners bemoaned the lack of textbooks and the poor quality of these textbooks in our schools.

The physical and social environment was also discussed as some of the factors impacting negatively growth mindset. They gave an example of how this study was interesting by learning through computer videos and

life examples that were very interactive. The discussants talked of the issue of sustainability in terms of growth mindset. They said that if what this study had subjected them to would be continued and sustained, it would yield a lot of results.

Conclusion

Growth mindset interventions, which aim to bolster students' belief that their general intellectual ability can improve and that can foster academic achievement ((Aronson J., Fried C. B, & Good c., 2002); (Blackwell L. S., Trzesniewski K. H. & Dweck C. S.,, 2007)) as can be seen in some of the examples we have picked from the findings: 16 representing 11.59 percent of the respondents said that it is not at all correct that one can learn new things and cannot make oneself smarter, 10 representing 7.24 percent said that the statement that one can learn new things but cannot make oneself smarter is a little not correct, 10 representing 7.24 percent were for both statements, 5 representing 6.54 the statement was a little correct and 97 representing 70.28 percent said that the statement that one can learn new things but cannot make oneself smarter was a lot correct. After the intervention, the responses were as follows: 88(63.77 percent) said that the statement was not at all correct, 27(19.57 percent) A little not correct, 0 for both, 15(10.87 percent) A lot correct and 5.80 percent) a lot correct.

What is seen as particularly characteristic about this data is that you see a swing from a lot correct to not at all correct, by and large exemplifying that the growth mindset intervention worked wonders on these pupils for they learnt during the intervention that their minds are not fixed and their brain has some elasticity like that of the muscle which can be changed and so their intelligence can be worked out and that they can be smarter.

From FGD it is certainly important that the study was conducted because the effects are edifying in the sense that there has been mindset change in terms of looking at intelligence and academic achievement. This has unlocked the success path in the subjects that were thought to be very hard and meant for those who had special intelligence. Given the right environment and resources, the pupils think they are all competitors in chemistry and other subjects.

In this research, we developed and tested if a growth mindset intervention could be of influence to augment academic outcomes in a 138 sample of students in low socioeconomic status compound schools of Chipata district in Eastern province of Zambia.

There is a difference in educational outcomes when compared to students from more affluent areas and boarding schools. There are several contributors to these attainment gaps, including environmental factors, parental expectations and broader cultural influence. These barriers likely undermine motivation to learn. Additionally, students are deterred from continuing their education beyond high school when they doubt their ability to handle learning challenges and question their sense of belonging in school. We suggest a growth mindset intervention can offset the belief that to be successful one must have an innate ability, thereby sparking motivation, efficacy, and sense of belonging.

We anchored our intervention in mindset theory, which differentiates between growth beliefs and fixed beliefs about human attributes (Dweck, 2006). Students with a growth mindset believe that intelligence is changeable and that they have the capacity to improve. These students also view setbacks as opportunities to develop their skills and use feedback as information to progress towards their goals. In contrast, students with a fixed mindset believe their intelligence is a static trait that cannot be enhanced. When facing challenges, these students get discouraged, question their ability, and disengage.

Considering the robust link between growth mindsets and effective self-regulatory processes and goal achievement, several researchers investigated if growth mindset interventions could bolster academic performance.

We examined if we could reliably shift mindsets and if this could affect the academic results within a month. We predicted that growth mindsets would be critical for fostering learning motivation including intrinsic motivation (e.g., enjoyment), value (e.g., utility of learning), and persistence (e.g., intentions to pursue education beyond high school). A fundamental predictor of motivation to learn is evaluations of potential for mastery of the subject and a growth mindset captures these expectations about learning abilities.

Additionally, many correlational and experimental findings support a link between growth mindsets and positive academic outcomes including valuing learning and being motivated to learn. And, at least two interventions ((Aronson J., Fried C. B, & Good c., 2002); (Blackwell L. S., Trzesniewski K. H. & Dweck C. S.,, 2007)) have demonstrated the potential for growth mindset interventions to help students enjoy and be more motivated to engage academically.

Students with a fixed mindset tend to view failures as an indication of a personal deficiency, which erodes their sense of self-efficacy. In contrast, students with a growth mindset tend to view failure as part of the process, which contributes to their self-efficacy, even when the work is hard. This is important because learning self-efficacy is a robust predictor of academic persistence and performance (e.g., Zimmerman, 2000).

In summary, we examine the efficacy of the Growing Minds intervention in a randomized controlled trial. We hypothesized that this program would strengthen growth mindsets of intelligence, would enhance academic attitudes including motivation to learn, learning efficacy, and school belonging, with implications for grades in chemistry.

When chemistry scores are compared both in the pretest and posttest, there is no slightest doubt that the grades have swung on the improvement side of the academic pendulum. In a summation, the average scores are 56.3 and 62.2 in the pretest and posttest respectively and the average difference is 5.9.

In this work, we developed a growth mindset intervention to promote positive academic outcomes in students from low socioeconomic status homes going to Day Secondary schools. This intervention led to stronger growth mindsets within four weeks. In turn, these mindsets predicted more positive academic attitudes including learning motivation and learning efficacy and correlated with higher final grades in chemistry as well. Growth mindset interventions offer a promising approach, combined with other effective techniques, to counteracting the disadvantages faced by students living in low socioeconomic status compounds and going to day secondary schools dotted around these compounds. It will also guide research and policy-related efforts around creating interventions that not only stimulate students' mindset growth, but also create school environments that support students' learning.

What is known about this topic: There exist barriers to the attainment of grades in chemistry among the low-income students in Chipata district which are the self-defeatist attitude that chemistry is hard and it is for the born bright and that the environment contributes in perpetuating this attitude like teachers favouring those whose results in chemistry are top notch and looking down upon those struggling as 'empty tins.'

What this study adds: It has demystified the presumptions or belief that chemistry is for the naturally born intelligent and that those were not born with 'grey matter' for chemistry will not improve ad infinitum. With instruction, practice and effort the path to the higher scores in chemistry is adequately lighted up and everyone else becomes the first among equals. There is also a need to understand and better address pedagogical methodology embracing the medium of instruction and the creating an enabling environment that will catapult high scores in chemistry.

Authors' contributions: Mark Mwanza working under close supervision of designed the study, coordinated data collection and interpretation of data and revised the manuscript. He also did the data analysis and drafted the manuscript. He was also at the helm of data collection and interpretation of data. The supervisor approved the final version of manuscript.

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ADDENDUM 1: Growth Mindset Measuring Instrument

Indicate from one up to five how you agree with the following statements

a. You can learn new things but you cannot make yourself smatter

Not at all correct	A little not correct	Both	A little correct	A lot correct
1.	2.	3.	4.	5.

b. You cannot change how intelligent you are

Not at all correct	A little not correct	Both	A little correct	A lot correct
1.	2.	3.	4.	5.

c. How intelligent you are is something about you that you cannot change very much

Not at all correct	A little not correct	Both	A little correct	A lot correct
1.	2.	3.	4.	5.

d. People are born intelligent or not intelligent. This cannot be changed

Not at all correct	A little not correct	Both	A little correct	A lot correct
1.	2.	3.	4.	5.

We use this rating scare which has been used by other researchers before and has proven to be reliable (PorterTenelle, et al, 2020).

ADDENDUM 2: Measuring Academic Behaviour

Indicate from 1 up to 4 how you agree with the following statements

1) The effects of failing chemistry are bad and should be avoided

I strongly agree	I agree	I disagree	I strongly disagree
1	2	3	4

2) I believe experiencing failure in chemistry hurts my learning and growth

I strongly agree	I agree	I disagree	I strongly disagree
1	2	3	4

3) Learning is important to me

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

4) I put a lot of effort into learning

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

5) I like learning chemistry

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

6) I like chemistry" and "chemistry is personally important to me.

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

7) I plan to continuing with learning after school

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

8) On chemistry assignments I put in a lot of effort

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

9) I do not give up when chemistry becomes difficult

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

10) When I am handling a challenging chemistry problem, I do not give up until I find a solution

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

11) I choose to do more difficult chemistry questions instead of easy ones

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

12) I love chemistry because it challenges me to think

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

13) If I get a disappointing grade in chemistry, I do my best to improve on the next one.

I strongly disagree	I disagree	I agree	I strongly agree
1	2	3	4

14) How satisfied do you feel about your life?

Very Disappointed	Disappointed	Happy	Very Happy
1	2	3	4

15) How close are you with your best friend?

Not Close	Just Close	Very Close	Extremely Close
1	2	3	4

Figure 5: Source: Adapted from Porter et al. (Tenelle P. et al., 2020)

ADDENDUM 3: Instrument to Measure the Push and Pulls factors of Growth Mindset

As a research participant, an educator, you have contributed to this research. May you answer the following questions which will be help with the evaluation of the research?

1. Did you find this research helpful?
2. What factors or practices do you think positively impact the Growth Mindset?
3. What factors or practices do you think negatively impact the Growth Mindset?
4. Suggest what elements you think we should add or remove in order to enhance future research in this field.
5. If you have anything else to say in connection with this research, may you express your views please

Thank you very much for participating in this research. I pledge confidentiality of the shared information.