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Needs Assessment for Facilitators in Teaching of STEM Subjects in Under-Resourced Rural Schools: Case of Lupane and Hwange Districts in Zimbabwe

Desmond Mwembe [1]*, Isabel Linda Zulu [2], Precious Mdlongwa [1]

[1] Department of Statistics and Operations Research, National University of Science and Technology, Ascot Bulawayo, ZIMBABWE
[2] Department of Mathematics, University of Eswatini, Kwaluseni, ESWATINI
***Corresponding Author:** desmond.mwembe@nust.ac.zw**

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ABSTRACT

The aim of the study was to determine the various needs facilitators and schools lack for effective teaching of science, technology, engineering, and mathematics (STEM) subjects, in both the primary and secondary under-resourced rural schools. This survey was conducted from February 2019 to March 2019, in Lupane and Hwange Districts. A multi-stage sampling method was used for collecting data. Focus group discussions were also used in collecting data and were conducted prior to issuance of questionnaires for completion by the participants. In analyzing data, odds ratio (OR) were calculated to compare the relative odds between outcomes and variables of interest. The survey found out that female facilitators were lagging behind in the uptake and training of teaching of STEM subjects, which could be attributed to family responsibilities. It was established that some needs such as lesson delivery skills, research skills and capacitation were highly needed in primary schools as compared to secondary schools. While other needs identified were equally needed in both primary and secondary schools. These include but are not limited to conducting team teaching with other facilitators, linking topics and lessons across classes and lessons, application skills and STEM activities. It was highly recommended that primary and secondary school facilitators be funded to attend capacitation platforms in teaching of STEM subjects for effective teaching of STEM in rural schools and using locally available resources, as limited resources is the order of the day in rural schools. Schools must be equipped with tools and structures such as laboratories. If schools cannot build laboratories, it was recommended that mobile laboratories be established to improve teaching of STEM subjects in under-resourced rural schools. One mobile laboratory can service many schools in the district and improve the pass rate of STEM subjects.

Keywords: needs assessment, under-resourced, primary, secondary, facilitators, Zimbabwe

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BACKGROUND AND INTRODUCTION

Lupane and Hwange are districts located in the Matabeleland North Province of Zimbabwe with Lupane as the Provincial capital. Lupane is approximately 172 km from Bulawayo along the Victoria Falls road. There are roughly 28 secondary schools in Lupane and pass rate is generally low, 20.74%, according to the last published statistics from Ministry of Primary and Secondary Education (2017) and this is due to rural location of schools and long distances travelled by learners to the nearest under resourced school. There are roughly 106 under resourced primary schools scattered around the district with a passrate of 19.57% in 2017. Hwange district is primarily a coal mining district. Hwange is as well along Bulawayo-Victoria Falls road. It is roughly 100 km from Victoria Falls by road. Hwange has highly under resourced primary and secondary schools. Learners still walk long distances to the nearest under resourced primary or secondary school. There are 64 rural primary schools with a passrate of 39.7% in STEM subjects and 23 rural secondary schools with an overall passrate of 26.22% in 2017.

Science, Technology, Engineering, and Mathematics (STEM) is the talk of the century in education. Many countries have adopted the teaching of science, technology, engineering and mathematics in their education system. Zimbabwe has also followed suit in teaching of STEM subjects. STEM can be defined by the separate and related subjects such as science, biology, chemistry, physics, mathematics, technology, and engineering (Kim et al., 2015; Roberts, 2012; Xie et al., 2015). However, a new emphasis views STEM education as an integrated approach that blends the STEM disciplines in a relevant learning context in order to solve a real-world problem (Jolly, 2017; Kelley & Knowles, 2016; Kim et al, 2015; Roberts, 2012; Truesdell, 2014; Xie et al., 2015). The question is on whether rural schools are managing the teaching of STEM subjects effectively given the demands of STEM teaching viz-a-vis the resources rural schools have.

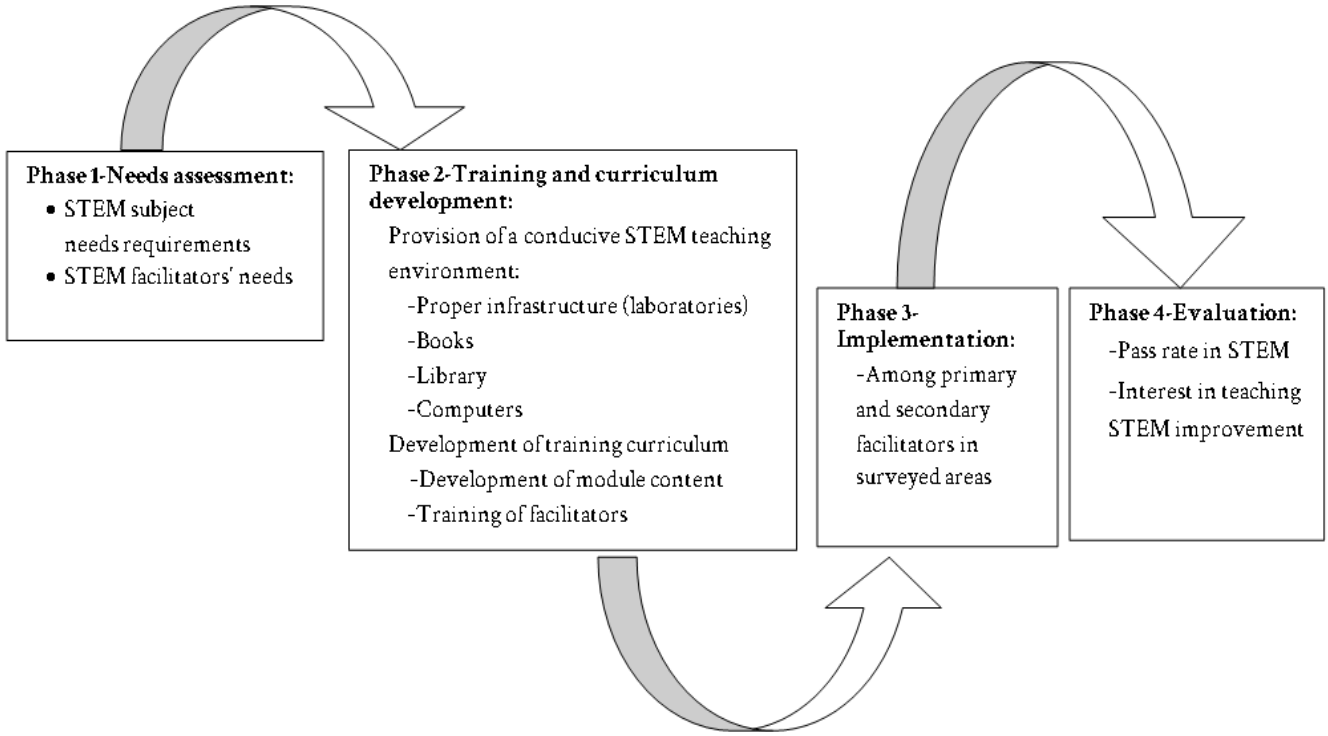

Figure 1. Conceptual framework of the Lupane-Hwange needs assessment survey

This prompted the needs assessment survey in rural schools of Lupane and Hwange to establish whether there is a need to empower facilitators and schools so that teaching of STEM subjects will be done effectively. Needs assessment according to Gall et al. (2003) and McCawley (2009) is a systematic approach to investigate the knowledge, interest or attitude of a defined group involving a particular topic. In this research, instead of a particular topic, investigation for a particular science subject was conducted.

This leads to a conceptual framework that will be done in four phases. First phase will be on needs assessment. This will be done to establish facilitators are in dire need so as to teach STEM subjects effectively. These will be put into two categories which are namely infrastructure and personal development of facilitators. Phase one will be followed by phase two. Phase two will involve the provision of the needed infrastructure and training that facilitators lack to provide effective teaching of STEM subjects.

Phase 3 and 4 will be implementation and evaluation, respectively. Once basic requirements are met, then implementation of the program of teaching STEM subjects will start and finally evaluation will be done. The evaluation will be focusing on pass rate with respect to STEM subjects and interest of facilitators in teaching of STEM subjects whether it has been boosted or not. This is summarized in **Figure 1**.

Purpose and Rationale

The purpose of this research was to assess the educational needs of facilitators and schools in teaching of STEM subjects in Zimbabwe. The study also tries unveil the gaps and needs in rural schools and needs in individual facilitators in teaching of STEM subjects. Most researches do not address the plight of rural schools. Rural schools are hard hit by shortage of resources, infrastructure and manpower, gadgets and at times network connection. This research endeavours to address this gap and compare the results with what is mostly found in other settings like urban areas. After needs assessment is done, corrective measures in building and strengthening primary and secondary school facilitator's capacity in using tasks and projects when teaching STEM subjects in under-resourced areas in Zimbabwe will be formulated. The information from this research will also guide the programmers to better address identified needs by facilitators to maximize the effectiveness of facilitators in delivering lessons, utilize scarce resources and use locally available resources to ensure high quality teaching of STEM subjects in Zimbabwe.

METHOD

Data Collection

The survey was conducted in Lupane and Hwange primary and secondary schools. Only science facilitators involved in teaching of STEM subjects were involved. Districts and schools were randomly sampled using multi-stage simple random sampling and all primary and secondary schools in both districts had an equal chance of being included in the survey. In each school, all facilitators involved in STEM teaching were interviewed.

Two different questionnaires were designed, one for facilitators and one for learners. The Ministry of Primary and Secondary District Schools Inspectors (DSI) were consulted on whom to approach to collect data at district level. To maximise reliability and validity, only STEM teaching facilitators were included in survey. All students at primary and secondary level were included as they do STEM subjects.

A focus group guiding data collection instrument was used. The focus group discussions were for both facilitators teaching STEM subjects and students doing STEM subjects at primary and secondary level. A facilitator could not have majored in science subjects in his or her studies at college but provided he or she was teaching STEM subjects, the facilitator was included in the survey. Initially, a focus group discussion was conducted where facilitators would give their views in different areas or aspects associated with teaching of STEM

Table 1. Gender distribution by taught academic level

Gender	Taught level		Total
	Primary	Secondary	
Male	15	32	47
Female	48	20	68
Total	63	52	**115**

subjects. Later, questionnaires were given to facilitators for completion. Odds ratio (OR) were calculated for each area of need.

Data Analysis

There were 47 (40.9%) male facilitators and 68 (59.1%) female facilitators who participated in the survey. The modal age of the facilitators was 30 years. This is generally a young sample. The distribution of facilitators by gender in schools is shown in **Table 1**.

The results show that there are more female science facilitators in primary schools as compared to males. This implies that there are more males in secondary schools as compared to female facilitators (OR=0.195, 95% CI=0.087-0.437, and p=0.001). The odds of a male facilitator being at a primary school are 0.195, which translates to the odds of a female facilitator being at a primary science facilitator is 5.1282. It means that females are approximately five times more often being primary science facilitators as compared to their male counterparts.

Most of the facilitators were science major from their training colleges. Even though most had majored in science subjects at college, there are still facilitators who did not major in science but who are teaching STEM subjects. Most teachers after college shun rural schools (Harris & Hodges, 2018), worse more if she or he has a major in science since science facilitators are in demand nationally, regionally or even internationally. This shortage of facilitators majoring in STEM teaching forces school administrators to give STEM subjects to facilitators who did not major in teaching science subjects at college or university.

There were 100 permanent facilitators, 4 temporary and 11 contract facilitators. Of the 4 temporary facilitators, 3 were from primary schools and just 1 was from a secondary school. As for contract facilitators, 8 were from primary and 3 were from secondary schools. There was also interest of checking gender balance in the composition of temporary and contract facilitators. It was established that most of the temporary facilitators were females (75%) and most of the contract workers were males (55%).

Experience in teaching STEM subjects was one other factor that was looked into. Facilitators would not advance their knowledge in STEM teaching simply because they believe they have a lot of experience in the teaching field. Just as Yasar et al. (2006) found out in their study, teachers had less interest in learning design, engineering and Technology (DET) and interest decreased with increase in experience. This was asserted by Bayer (2009).

It was established that experience was decreasing with number of years in both primary and secondary facilitators. As depicted in **Figure 2**, the majority of facilitators were in the less than one-year experience in teaching of STEM subjects and very few above 20 years. This has an implication on training the facilitators in teaching STEM subjects in primary and secondary schools of Zimbabwe. There is simply lack of experience and training is needed as soon as possible. Or those trained in STEM and with more experience leave for greener pastures and

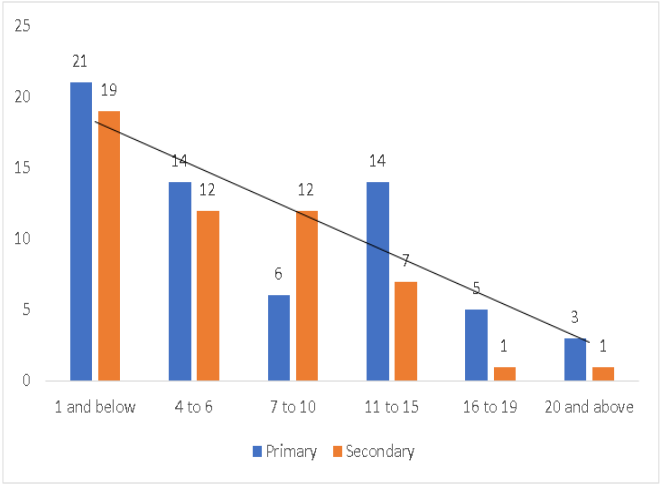

Figure 2. Experience of facilitators in teaching STEM subjects

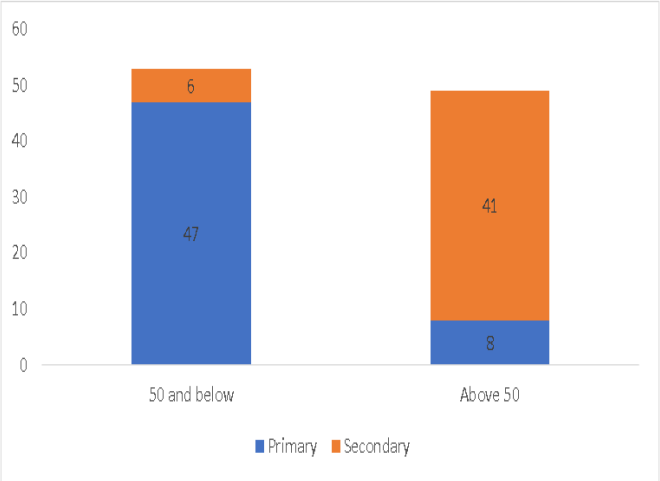

Figure 3. Number of learners per facilitator

hence there is need for policies that would retain the STEM teachers in schools.

Number of learners per facilitator in rural schools is generally high. A maximum of 50 learners per facilitator was used, but surprisingly, there were facilitators who still had more than 50 learners in a class. Most primary facilitators had 50 and below learners and a few had above 50 learners.

As **Figure 3** depicts, the majority of secondary school facilitators had more than 50 learners per facilitator. There were few facilitators who indicated that they had learners below 50. An optimum number of learners per facilitator need to be established so that implementation of STEM teaching will be fruitful in lowly resourced rural schools. The number of learners per facilitator for an effective teaching of STEM subjects needs to be established given the resources rural schools have. This high facilitator to learner ratio also revealed the shortage of secondary schools in rural areas.

Training of facilitators in teaching of STEM subjects is an ongoing process. During the time of the survey, 43.4% of the primary school facilitators had undergone training in teaching of STEM subjects while its complement had not yet gone through the training. For secondary school facilitators, 56.6% had gone through the training and its complement had not done the training. This again shows that more

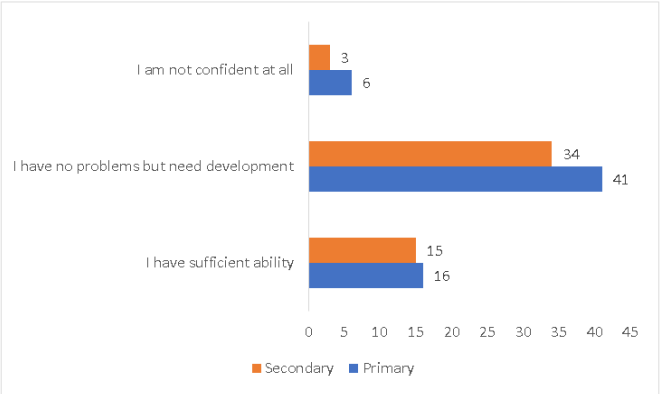

Figure 4. Facilitators' competence in teaching of STEM subjects

secondary school facilitators had gone through the training as compared to primary school facilitators. The odds of a primary facilitator going through training is 0.230 (95% CI=0.096-0.551 and p=0.001). Secondary school facilitators are 4.35 times more often to have undergone training of teaching of STEM subjects as compared to primary school facilitators. This informs of the structure of the primary teacher training programme in Zimbabwean colleges that may need to introduce Science content across the board for all teacher trainees.

The survey established that more male facilitators (72.3%) went through training of teaching of STEM subjects. Female facilitators were 61.8% who had done training in teaching of STEM subjects. Male facilitators are more likely to undergo training as compared to their female counterparts even though it is not statistically significant (OR=1.619, 95% CI=0,724-3.621, and p=0.239).

Information on whether facilitators are comfortable with the teaching of stem subjects was also sought. As summarised in **Figure 4**, most facilitators in both primary and secondary schools indicated that they were comfortable but still needed some training in the area. This shows that there is a degree of being not comfortable in teaching STEM subjects and primary facilitators are leading in showing degree of being not comfortable. It was not a surprise to find facilitators who were bold enough to indicate that they were not comfortable at all to teach STEM subjects and majority was found in primary schools.

Personal Development

In Lupane and Hwange districts, facilitators are developing themselves to be in line with the new development of teaching STEM in schools. It was established that 9.6% of the male and female facilitators are currently studying STEM subjects at college. This is quite a small number of facilitators developing themselves towards effective teaching of STEM subjects. On the same note, it was established that 31.3% of the male facilitators were not studying STEM subjects and 49.6% of the females were not studying STEM subjects in any college. This indicates that there were more males studying STEM subjects as compared to females. There is need to encourage females to do the same. An attributing factor could also be the fact that these teachers were self funding their studies and hence only a small fraction of teacher could afford. This calls for alternative refresher courses and workshops that can be facilitated by the Ministry to cover the gap.

Enrolment in personal development studies was further analysed whether it was at degree or diploma level. It was established that 90.9% of the males were advancing their studies in the teaching of STEM at degree level and only 9.1% were doing that at diploma level. Female facilitators were at 66.7% who were studying teaching of STEM subjects at degree level and 33.3% were studying teaching of STEM subjects at diploma level. Male facilitators were 5 times more often to go and study a degree than studying a diploma as compared to female facilitators (OR=5.000, 95% CI=0.419-59.657, and p=0.178). When facilitators were asked on whether they had an intention of advancing their STEM teaching studies or not, it was established that 92.6% of the male facilitators were planning to go for degree studies in STEM teaching and only 7.4% had plans to go for diploma studies in STEM teaching subjects. As for females, 82.9% had plans to go for a degree but 17.1% had plans to go for a diploma. This showed that there were very few or close to none degree holders who were teaching STEM subjects in these rural schools. This called for the Ministry to offer support and pay much more attention to rural schools in terms of resource allocation in personnel development.

The survey established that more secondary school facilitators had an intention of going to study teaching of STEM subjects as compared to primary school facilitators. The odds of a primary school facilitator planning to go for training to teach STEM subject is 0.313 (95% CI=0.102-0.964 and p=0.037). The odds of a primary school facilitator going for STEM teaching training are less than that of a secondary school facilitator going for the same activity. In another way, secondary school facilitators are 3.2 times more often to think of or plan for studying how to teach STEM subjects as compared to primary school facilitators. Female and primary school facilitators should encourage to study teaching of STEM subjects in higher learning institutions.

Training in the new curriculum and teaching of STEM subjects

Effective delivery of STEM teaching is highly dependent on whether facilitators received training in the new curriculum or not. Clotfelter et al. (2007), Darling-Hammond (2010), Laine (2008), and Makhmasi et al. (2012) indicate that for the implementation of STEM teaching, schools require highly qualified teachers and students' performance was improved by qualified teachers. The survey found out that, 35.9% of the male facilitators had received training in the new curriculum and 46.1% of the females had as well received training in the new curriculum. The training was through attendance of workshops or through new teachers' college curricula which include teaching of STEM subjects in their training of facilitators. During the time of the survey, 50% of both male and female facilitators had not received training in the new curriculum. It was also revealed that more females were trained in the new curriculum as compared to males (p-value=0.005). More staff development activities in the new curriculum for secondary facilitators were needed, as also supported by Zhou (2017) in his findings.

Perceptions of facilitators on teaching STEM subjects before and after exposure to teaching of STEM subjects

The views of facilitators about teaching STEM subjects were recorded. The survey established that facilitators were learning new things with their learners because of teaching STEM subjects, facilitators also indicated that there was more burden in lesson preparation due to additional subjects or subject material added due to the introduction of STEM in primary and secondary schools. Further, facilitators showed that they were struggling to teach STEM subjects because it was not their area of specialisation (OR=0.138, 95% CI=0.038-0.504, and p-value=0.001). These three views were more noticeable in primary schools than secondary schools. Summary of these statistics is in **Table 2**. The survey established that more

Table 2. Facilitators' perceptions about teaching STEM subjects before exposure

Perception		Level		Odds ratio	p-value	95% CI for OR
		Primary (%)	Secondary (%)			
I like stem subjects and enjoy teaching stem to my students	Disagree	3(37.5)	5(62.5)	0.542	0.413	0.123-2.394
	Agree	52(52.5)	47(47.5)			
I learn new things with my learners	Disagree	1(14.3)	6(85.7)	0.137	0.037	0.016-1.178
	Agree	56(54.9)	52(47.7)			
More burden in lesson preparation due to additional subjects or subject material	Disagree	20(37.7)	33(62.3)	0.303	0.003	0.137-0.670
	Agree	36(66.7)	18(33.3)			
I am struggling to teach stem subjects because it is not my area of speciality	Disagree	39(45.3)	47(54.7)	0.138	0.001	0.038-0.504
	Agree	18(85.7)	3(14.3)			
Stem subjects are not needed in primary school level	Disagree	51(52.6)	46(47.4)	1.663	0.449	0.441-6.266
	Agree	4(40.0)	6(60.0)			

Table 3. Facilitators' perceptions about teaching STEM subjects after exposure

Perception		Level		Odds ratio	p-value	95% CI for OR
		Primary (%)	Secondary (%)			
My feelings of resistance to stem subjects have decreased	Disagree	14(50.0)	14(50.0)	0.949	0.905	0.399-2.257
	Agree	39(51.3)	37(48.7)			
I have since improved my lesson preparation and delivery ability	Disagree	3(23.1)	10(76.9)	0.247	0.032	0.064-0.956
	Agree	51(54.8)	42(45.2)			
I became interested in new discoveries	Disagree	2(25.0)	6(75.0)	0.300	0.133	0.058-1,562
	Agree	50(52.6)	45(47.4)			
I gained other skills in lesson preparation and delivery	Disagree	5(41.7)	7(58.3)	0.640	0.470	0.189-2.166
	Agree	48(52.7)	43(47.3)			
I dislike stem subjects now	Disagree	48(51.6)	45(48.4)	1.067	0.939	0.205-5.561
	Agree	3(50.0)	3(50.0)			

secondary school facilitators were trained in teaching STEM subjects as compared to primary school facilitators (OR=0.230, 95% CI=0.096-0.551, and p-value=0.001). This explains the reason why primary school facilitators were struggling in teaching STEM subjects and learning new things most of the time.

Primary school facilitators were 7.3, 3.3, and 7.2 times more often to say they were learning new things, had more work due to additional material and were struggling in teaching STEM subjects as compared to secondary school facilitators, respectively. Otherwise, other views were common both in secondary and primary schools. Facilitators in primary and secondary schools both agreed that they enjoyed teaching stem subjects and there was mutual disagreement that STEM subjects were not needed at primary school level (OR=1.663, 95% CI=0.441-6.266, and p-value=0.449).

After exposure to teaching of STEM subjects, the survey established that more primary school facilitators had improved their lesson preparation and delivery ability. This was more visible among primary school facilitators as compared to secondary school facilitators. **Table 3** summarises this information. Some attributing factors came from lack of resources and exposure of facilitators in making use of locally available resources for teaching STEM subjects.

Facilitators' training needs

The survey also sought information on areas that facilitators would want to be capacitated in. As previously found by Owens et al. (2018), STEM facilitators' areas of professional development are not fully understood. **Table 4** summarises this information and it can be concluded that, primary school facilitators were more interested in being trained in the following areas as compared to secondary school facilitators:

1. Lesson preparation skills (OR=0.240, 95% CI=0.037-0.794, and p-value=0.014).
2. Assessment skills (OR=0.277, 95% CI=0.092-0.837, and p-value=0.018).
3. Lesson delivery skills (OR=0.175, 95% CI=0.054-0.568, and p-value=0.002).
4. Research skills (OR=0.165, 95% CI=0.034-0.793, and p-value=0.013).
5. Knowledge improvement on teaching of STEM subjects (OR=0.429, 95% CI=0.195-0.940, and p-value=0.033).
6. Improvement on methodology of cross subject understanding (OR=0.212, 95% CI=0.05-0.274, and p-value=0.043).

Other areas which include developing teaching material, sourcing useful teaching material and how to use it, team teaching and many more were equally needed by both primary and secondary school facilitators (p>0.05) in each case. Of particular interest are the following needy areas which were needed by primary school facilitators the same way they were needed by secondary school facilitators:

1. Conducting team teaching with other facilitators (OR=0.979, 95% CI=0.231-4.146, and p-value=0.977).
2. Linking topics and lessons across classes and lessons (OR=0.957, 95% CI=0.311-2.948, and p-value=0.940).
3. Application skills (OR=1.175, 95% CI=0.336-4.114, and p-value=0.801).
4. STEM activities (OR=0.925, 95% CI=0.125-6.818, and p-value=0.939).

Table 4. Areas of improvement suggested by participants

Area of improvement		Level		Odds ratio	p-value	95% CI for OR
		Primary (%)	Secondary (%)			
How to develop teaching material	Disagree	3(30.0)	7(70.0)	0.385	0.173	0.094-1.580
	Agree	49(52.7)	44(47.3)			
Sourcing useful teaching material and how to use them	Disagree	3(37.5)	5(62.5)	0.575	0.461	0.130-2.545
	Agree	48(51.1)	46(48.9)			
Conducting effective team teaching with other facilitators	Disagree	4(50.0)	4(50.0)	0.979	0.977	0.231-4.146
	Agree	48(50.5)	47(49.5)			
Linking topics and lessons across classes and subjects	Disagree	7(50.0)	7(50.0)	0.957	0.940	0.311-2.948
	Agree	47(51.1)	45(48.9)			
Making a one-hour lesson plan	Disagree	6(37.5)	10(62.5)	0.548	0.277	0.183-1.638
	Agree	46(52.3)	42(47.7)			
STEM activities that are suitable for the developmental stages of children	Disagree	2(50.0)	2(50.0)	0.925	0.939	0.125-6.818
	Agree	53(52.0)	49(48.0)			
Culture of foreign games	Disagree	9(36.0)	16(64.0)	0.458	0.096	0.181-1.161
	Agree	43(55.1)	35(44.9)			
Useful games	Disagree	3(27.3)	8(72.7)	0.329	0.103	0.082-1.319
	Agree	49(53.3)	43(46.7)			
Research skills	Disagree	2(16.7)	10(83.3)	0.165	0.013	0.034-0.793
	Agree	51(54.8)	42(45.2)			
Application skills	Disagree	6(54.5)	5(45.5)	1.175	0.801	0.336-4.114
	Agree	48(50.5)	47(49.5)			
Practical skills	Disagree	3(33.3)	6(66.7)	0.426	0.234	0.101-1.799
	Agree	54(54.0)	46(46.0)			
Lesson preparation skill	Disagree	4(23.5)	13(76.5)	0.240	0.014	0.037-0.794
	Agree	50(56.2)	39(43.8)			
My knowledge on teaching stem subjects is weak	Disagree	24(40.0)	36(60.0)	0.429	0.033	0.195-0.940
	Agree	28(60.9)	18(39.1)			
How to choose materials	Disagree	4(40.0)	6(60.0)	0.626	0.486	0.166-2.361
	Agree	49(51.6)	46(48.4)			
Methodology of cross subject understanding	Disagree	2(22.2)	7(77.8)	0.212	0.043	0.050-0.274
	Agree	54(57.4)	40(42.6)			
Websites for useful teaching materials	Disagree	0(0.0)	2(100.0)	-	-	-
	Agree	53(51.5)	50(48.5)			
Useful lesson plans	Disagree	3(33.3)	6(66.7)	0.459	0.281	0.108-1.945
	Agree	49(52.1)	45(47.9)			
Assessment skills	Disagree	5(36.3)	14(73.7)	0.277	0.018	0.092-0.837
	Agree	49(56.3)	38(43.7)			
Lesson delivery skills	Disagree	4(20.0)	16(80.0)	0.175	0.002	0.054-0.568
	Agree	50(58.8)	35(41.2)			

DISCUSSION

Though teaching of STEM subjects has started in most Zimbabwean schools, rural and urban, rural schools are facing a lot of challenges. These challenges range from facilitators' capability to teach STEM subjects to availability of resources in schools to fully teach STEM subjects effectively. These results are consistent with what Ingersoll and Perda (2009), Kuenzi (2008), Mukomana (2019), Shernoff et al. (2017), Kadziya and Ndebele (2020), and Sid W. Richardson Foundation Forum (2012) found.

The research found out that these challenges are more pronounced in rural primary schools as compared to rural secondary schools of Zimbabwe. Rural primary schools have no facilities and equipment to demonstrate to learners. In a simple information communication technology (ICT) lesson, facilitators used to draw a computer mouse. When the correct picture comes in the final national examination, learners could not recognise the computer mouse because rural schools do not even have computers and at times electricity to demonstrate. Most rural secondary schools have turned some of the classrooms into laboratories. Chemicals were pronounced to be very expensive in the region and hence learners perform practicals only during examinations, first time with no practice before the examinations.

Among the rural primary school facilitators, it was established that facilitators need training in research skills, lesson preparation skills, lesson delivery skills, assessment skills, knowledge improvement on teaching of STEM subjects and improvement on methodology of cross subject understanding more than rural secondary school facilitators. This basically boils down to training facilitators in these areas. In rural schools, it was found out that there were facilitators who were not even trained to teach STEM subjects but are currently teaching these subjects. This is due to the fact that STEM facilitators shun rural schools and are easily absorbed into urban schools soon after training in colleges and universities hence rural schools are left with insufficient STEM facilitators. These results are in line with a comparative study by Yang et al. (2015).

Facilitators who happen to be teaching STEM subjects even though it's not their area of specialisation have a different view about STEM

teaching after the exposure to teaching of STEM subjects. Many say they have changed their attitude towards STEM teaching. These are facilitators who have been teaching STEM subjects for more than a year. These results are in line with what Bolster (1983) and Guskey (2002a, 2002b) and Tal et al. (2001) found. Time and effort is needed to change facilitators' attitudes towards teaching of STEM subjects. The research found that there were no differences in change of attitudes of primary and secondary school facilitators. These findings echo what Penuel et al. (2007) found. This then will make it easier to train in-service facilitators on STEM teaching through workshops as they have better appreciation of STEM teaching than before being engaged in STEM teaching.

Another aspect that was established is lack of knowledge in using websites. Most rural schools do not have electricity and computers to do online research. Rural facilitators are bereft of research skills since they are not exposed to these gadgets for practice so as to impart the same knowledge to their learners. As Ejiwale (2012) puts it, educators are no longer dictators in the classroom but facilitators. They are actually facilitating on a try and error method and this affects learners' trust in their facilitators.

In a rural school, most facilitators are less experienced and this has an impact on many aspects of lesson delivery in the classroom or science laboratory. The compromised aspects will range from lesson planning up to lesson delivery. Previous researches by Cohen (2005), Gardner et al. (2019), Komarraju (2013), and Singh et al. (2002) have similar findings on the attributes of a teacher when delivering a lesson.

The survey found out that, generally, there is low uptake by facilitators to go and study teaching of STEM subjects. The reason why there is low uptake were unaffordable expenses that facilitators are supposed to settle in terms of fees, transport fares, accommodation and food expenditures to further their education or knowledge in teaching of STEM subjects. Some of the comments from focus groups discussions were:

> "Hmmm, I cannot afford university fees or even college fees to upgrade myself."

This is necessary as it improves their lesson planning and delivery skills. Furthermore, higher qualification improves motivation of students in learning of STEM subject (Godhaber & Brewer, 1997, 2000; Wayne & Young, 2003). This finding is also in accord with Mabhanda (2016) that there is STEM-phobia among students due to unqualified and barely motivated facilitators.

There is a discussion of the same results by Lesseig et al. (2016), Nadelson and Seifert (2013), Nadelson et al. (2012, 2013), and Van Haneghan et al. (2015) that most often facilitators need is support that will boost their effectiveness in teaching of STEM subjects. There is mention of improvement in confidence of teaching of STEM subjects after attending professional development programs.

When asked on whether professional development is vital, some of the reported responses were:

> "Yes, it is very important as it improves the delivery skill and exposure to some of the scientific gadgets like computers improves my understanding of the subject and hence will teach with confidence."

Another crucial area of need was on the perception of facilitators on teaching of STEM subjects. It was discovered that facilitators have a negative perception in teaching STEM subjects. As according to Owens et al. (2018), professional development is positively correlated to the district size. This was contrary to what this research established. The two districts had no association between facilitators' professional development and size. This was largely due to the fact that the district had scarce resources for implementation of STEM teaching. These results are also not consistent with what Shernoff et al. (2017) found. Teachers were interested in integrated approaches to STEM teaching while in this research, very few facilitators were willing in teaching STEM subjects due to too much work, inefficiency and non-proficiency in the new curriculum, among other reasons.

There is little confidence in teaching these subjects as facilitators are struggling in teaching STEM subjects. This is more pronounced among primary school facilitators as compared to secondary school facilitators. The reason being that teaching of STEM was only introduced when they were in-service not in-training and were not thoroughly prepared and trained in teaching these subjects.

Findings by Feng and Ha (2016) show that improvement in facilitator's confidence inspires learners hence easy implementation of STEM in schools. Self-confidence by the teacher is crucial in teaching of STEM subjects. As found by Bahar and Adiguzel (2016), facilitator confidence was one of the factors that was influential in inspiring learners in choosing STEM subjects. This implies that self-confidence of the facilitator needs to be boosted to inspire more learners enrolling in STEM subjects. These findings are inconsistent though with those by Edzie (2014).

CONCLUSIONS AND RECOMMENDATIONS

The research established that primary school facilitators are less keen to train in teaching of STEM subjects. Experienced facilitators are also reluctant to do training of teaching of STEM subjects. Female facilitators were not prepared to undergo training in teaching of STEM subjects both in primary and secondary schools. Primary and secondary schools lack qualified STEM facilitators, facilities and equipment and at times, books to effectively teach STEM subjects.

It was noted that learner to facilitator ratio was too high in rural schools. For an effective teaching of STEM subjects, the facilitator to learner ratio should be low. Most facilitators had no confidence in teaching of STEM subjects but after exposure for some years, they gained confidence but there are aspects where they still need help such as team teaching and website use.

It is recommended that female facilitators and primary school facilitators be encouraged to train in teaching of STEM subjects. This could be through training in colleges and universities or simply attending workshops where teaching of STEM subjects is done. This can be somehow on-site peer to peer training, with facilitators experienced in the use of website helping their fellow facilitators on researching online if they have access to the necessary facilities.

Funding of rural schools is highly recommended. Funding could be in terms of equipment for rural schools, establishment of mobile laboratories or funding for training rural STEM facilitators in using locally available resources in teaching. Most facilitators could not afford

college or university fees hence their reluctance to do training in teaching of STEM subjects.

Facilitator to learner ratio should be lowered for an effective teaching of STEM subjects. With high facilitator to learner ratio, there will be no learning taking place in most of our rural schools. To achieve this, facilitators from college and universities trained in STEM teaching should be encouraged to go to rural schools. A strategy to encourage qualified STEM facilitators to go to rural schools must be developed.

Limitation and Scope for Further Research

Findings from this study are limited to similar rural schools and in a similar geographical setting. The findings cannot be generalised to urban schools or even rural mission schools which have funding from donors. This is limited to government rural schools with virtually no external funding from other donors apart from government.

Future research need to evaluate performance of students under new curriculum given the existing conditions in schools. There is also need to do a survey on staff development of the teachers since inception of the new curriculum. This will indicate whether there is preparedness for the teaching of STEM subjects being put on the ground for better teaching and better results in STEM subjects.

There is need also to evaluate how COVID-19 has negatively affected the teaching of STEM subjects in under resources schools.

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