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# Opportunities and Factors Affecting adoption of STEM Education: The Case of Gweru Polytechnic First Year Commerce Students.

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**Abstract** *The current study sought to explore the factors affecting adoption of STEM education by first year students at Gweru Polytechnic. The study aimed to solicit various ideas, opinions, perceptions and attitudes on factors that affect adoption of STEM education despite opportunities abound this education reform. Data were collected through face to face interviews, focus group discussions and open ended questionnaires. A randomly stratified sample was used to select 8 lecturers and 30 first year students in the Commerce division respectively. Themes emerged from the in-depth individual interviews were discussed. The data was organised and presented in figures and statistics in line with quantitative and qualitative approaches. The study used a case study design. STEM education has been hailed for empowering the students to develop scientific knowledge needed in every aspect of life. STEM workers earn significantly more and experience lower unemployment rates than in other fields. The study revealed that lack of knowledge; skills, positive attitudes and poor motivation for STEM were prevalent factors that affect adoption among students. It also emerged that there is acute shortage of teaching staff at secondary level and subjects like engineering and Technology do not feature in the secondary curriculum. Some of these factors attributed to stem-phobia resulting in students lacking interest and shun STEM subjects. The study recommends that STEM be taught to students from secondary schools by well-qualified and highly effective and motivated teachers. Furthermore, there is need for education to empower the parents, teachers and students for support of the innovation. Finally, the study recommends further research on a wider scale to be conducted by employing different methods to come up with generalisable results.*
**Keywords: -** engineering, innovation, opportunities, STEM, technology.

## I INTRODUCTION

On Zimbabwe independence the high levels of illiteracy was met by great social demand for education across the nation. As a new independent country education development was central to the investment in educating the population. Prominent education policies were pronounced and enrolments shot in both primary and secondary schools. To this effect teacher/pupil ratio rose up to 1/60 and acute shortage of teachers, classrooms and resources spurred and compromised quality education. Krueger (2003) warns that small classroom size significantly improves students' academic achievement. The level of literacy rose up to as high as 80% however, all this happened to the exclusion of STEM education to date. STEM education as a new phenomenon is receiving extensive publicity to heighten its adoption from primary level to university education. Nyerere (1968: 274) affirms that, "Education must impart knowledge and skills needed for family life and for participation in the development and maintenance of the community" The STEM education is tied around the subjects namely Science, Technology, Engineering and Mathematics. While Science and Mathematics were being taught with less inclination to the purpose and meaning it is attached today in different learning spheres. Most of the post secondary graduates have made entries into colleges and universities with little or no idea of opportunities, benefits and importance of STEM education in line with career choices. This oblique background to STEM education has somehow deliberately lost support from students who rally behind commercial subjects in polytechnic colleges. Generally, the structures left by the colonial masters used divide and rule, this is where the resource landscapes were designed specifically for men and women automatically marginalised and discriminated against.

On a contemporary note, STEM education has become an interesting topical phenomenon at local and international arena. The emphasis thrust being made in both Secondary and Primary Education Ministry as well

as in the Ministry of Higher and Tertiary Education. This education innovation is critical to the economic prosperity of Zimbabwe and other nations. The U.S. Department of Education (2011) underscored that, a labour force without a rich supply of STEM-skilled individuals will face stagnant or even declining wealth by failing to compete in the global economy, where discovery, innovation, and rapid adaption are necessary elements for success. It is critically important to take advantage of the education institutions of learning to embrace STEM education for the current and future success of the nation. Unless all stakeholders take it upon themselves STEM education can not effectively take place in Zimbabwe. In Zimbabwe this phenomenon appears to be new though it is not new but once this education package gets the blessings of educators, business community, parents and government it would herald an economic emancipation. STEM jobs are projected to grow at a fast pace relative to other occupations. From 2008 to 2018, STEM jobs are expected to grow 17.0 percent compared to just 9.8 percent for non-STEM jobs (http://www.bls.gov/emp/ep_table_106.htm).

**1.1 Purpose of the study**

This study seeks to explore opportunities that arise from pursuing STEM education and unearth factors that inhibit adoption of the initiative in polytechnics in Zimbabwe.

**1.2 The problem**

Improving science, technology, engineering, and mathematics (STEM) education, is now widely recognized as pivotal to the Zimbabwe's economic growth and security. Educators are now taken to task to motivate students' interest towards adoption of STEM education. It has been observed that some economic challenges haunting the nation manifest the lack of STEM education as a power house to employment creation. Despite the teaching of Science and Mathematics in secondary schools students fear pursuing STEM subjects. The continual lag in STEM education has adverse effects to students' future employment opportunities. The reasons for lack of adoption need to be identified and opportunities to STEM education need to be unravelled in order to widen the horizon of future employment opportunities to students.

**1.3 Objectives of the study**

The study sought to explore the following objectives:

- Identify opportunities that emanate from adopting STEM education.
- To establish factors inhibiting the adoption of STEM education by first year Commerce students.
- Explore strategies to motivate students adopt STEM education.

**1.4 Research questions**

1. What are the opportunities from adopting STEM education?
2. What factors inhibit the adoption of STEM education by first year Commerce students?
3. What strategies can be put in place to motivate students' interest to adopt STEM education?

## II Literature Review

The term "STEM education" refers to teaching and learning in the fields of science, technology, engineering, and mathematics; typically including educational activities across all grade levels, from pre-school to post-doctorate, and in both formal and informal classroom settings (Gonzalez, & Kuenzi, 2012). Education can articulate human development through facilitating acquisition of knowledge, skills and attitudes thus preparing an individual's road map to career opportunities. Bybee (2013) clearly articulates that the overall purpose of STEM education is to further develop a STEM literate society. Further more Bybee (2013) posits literacy spells out the combination of knowledge, attitudes, and skills to identify questions and problems in life situations, explain the natural and designed world, and draw evidence-based conclusions about STEM-related issues.

The changes in the global economy have been necessitated by changing workforce needs and this has seen The International Council of Associations for Science Education (ICASE) released the Kuching Declaration on Science and Technology Education. Part of the declaration included the following statement:

*"Access to high quality education is a fundamental right for all. In times of global vulnerability, issues such as sustainability, health, peace, poverty alleviation, gender equity, and biodiversity conservation need to be at the forefront of thinking, planning and actions related to strengthening STEM education (ICASE, 2013)."*

The above citation is a reminder of the need to reduce the STEM skills gap in the 21st centaury workforce. Zimbabweans can not afford to remain behind. Among the skills lagging are Global Awareness, Creativity and Innovation, Critical Thinking and Problem Solving, Communication and Collaboration, Information Literacy, Media Literacy, Technology literacy, and Life and Career Skills including productivity and accountability, leadership and responsibility. In United States of America the Texas initiative is particularly focused on

transforming schools into academies that engage teachers and students in STEM with the goal of improving high schools and the college readiness of students (Texas High School Project, 2006). Conceited efforts in curriculum reform must be able to drive students for them to receive the breadth of STEM education not as separate entity but counting on all STEM disciplines. Science, technology, engineering and mathematics (STEM) education is a relatively new mode of thinking about how best to educate high school students for the workforce and for post-secondary education. There are obstacles that may hinder today or in the future the children's desire to persue STEM subjects leading to STEM jobs in the pursuit of their careers.

**2.1 Opportunities of STEM education**

STEM education has proved to bear fruits to many post secondary students when it comes to issues of employment and income levels. Science occupations are high status and reward their incumbents with relatively high personal income and social prestige (Rothwell 2013, Xie & Killewald 2012). The ability to understand and use STEM facts, principles, and techniques are highly transferable skills that enhance an individual's ability to succeed in school and beyond across a wide array of disciplines. For instance, in STEM subjects learners use critical thinking to recognize a problem. In a research by the U.S. Department of Commerce Economics and Statistics Administration (2010) the following were opportunities that arise to STEM subject takers.

- STEM occupations are projected to grow by 17.0 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations.
- STEM workers command higher wages, earning 26 percent more than their non- STEM counterparts.
- More than two-thirds of STEM workers have at least a college degree, compared to less than one-third of non-STEM workers.
- STEM degree holders enjoy higher earnings, regardless of whether they work in STEM or non-STEM occupations.

According to (Rothwell 2013) STEM education in particular carries a premium in the overall labour market. Most STEM graduates go into STEM jobs, occupations that are among the highest paying and fastest growing. Besides it is researched that individuals who enter STEM careers experience lower unemployment rates compared with workers who enter other fields, which means STEM workers enjoy greater job security. Students who study STEM also are able to enter a variety of fields and earn a salary premium even when they pursue non-STEM occupations. Finally, STEM education boosts the competitive edge and innovative capacity of states and regions, which sustain economic growth. STEM wages cut above the rest when comparing to other non STEM workers at different levels of educational attainment. According to Cover et al (2011) the following more opportunities enjoyed by STEM job holders: STEM job holders enjoy 11 percent higher wages than their same-degree counterparts in other occupations, Equally important, workers in STEM jobs tend to experience lower unemployment rates than workers in other fields. The STEM workforce is a key component of an innovation economy and a key ingredient for creating new business clusters and jobs. Skilled technicians produce, install, and repair the products and production machines patented by professional researchers, allowing firms to reach their markets, reduce product defects, create process innovations, and enhance productivity (Phillip 2010). In short, STEM graduates bolters innovation and creation of several employment opportunities. Importantly there are payoffs in STEM education although the earnings of basic scientists have stagnated in recent decades (Xie & Killewald 2012).

## 2.2. Factors affecting adoption of STEM education

In a national study conducted by the Korea Science Foundation in 2003, students in primary and secondary education showed low levels of interest and satisfaction in science classes (Korea Science Foundation, 2004). The trend may have emanated from a multiple of reasons. For instance, in Zimbabwe the science subjects were meant for the few gifted thus already dividing students on the basis of performance not necessarily implying that those left to do integrate Science have no brains to do STEM subjects. Lack of preparation for postsecondary STEM study often jeopardises the student's credential or motivation to take up STEM subjects in post-secondary education. It is likely a fact that educators fail to motivate student interest in maths and science to the extent that learners often fail to see the connections between what they are studying and STEM career options. Stem education is affected by lack of qualified teachers who have knowledge in the teaching of STEM pedagogical lessons. At some time many classrooms are staffed with teachers who claim or purport to teach the so subjects yet they have no training background knowledge that helps students understand and appreciate STEM education. One factor noted to affect STEM education is student absenteeism and dropping out of school. In his research Rumberger (1987) feels that, high rates of dropping out of school create a negative momentum

for youths in society, particularly during difficult economic periods when even a high school diploma does not guarantee a job. So dropping out can signal bad academic orientation to STEM education and poor job opportunities. Researches indicated that students are not well prepared to be able to face future challenges in postsecondary education stem requirements. The educators also stifle adoption of the subjects as they fail to motivate students' interest in the pursuit of STEM subjects.

## III Research Methodology

The research adopted the quantitative and qualitative interpretive approach. A case study design was employed in this study. The qualitative approach was preferred because it allows the researcher to gain understanding of this social phenomenon from participants' perspectives in their natural settings, (McMillan and Schumacher, 2010). All the participants of this study were randomly and purposely selected. Data were collected through face to face interviews, open ended questionnaires and focus groups. Lecturers in charge (7) were individually interviewed and the responses were captured for further interpretation. Three focus groups of ten students each were conducted with students from the seven disciplines in the division. This study had chosen to use various sources of data analysis so that diverse points and views cast light up on a topic. Thus triangulation of data sources was used, qualitative researchers generally use this technique to ensure that an account is rich, robust, comprehensive and well-developed, (Denzin, 1978). All the data gathered in this study were qualitatively and quantitatively analysed.

## IV Findings and discussion

The study sought to find out the opportunities that emanate from pursuing STEM education and also establish factors that hinder the adoption of STEM education. All factors were grouped into family related personal and institutional related. Opportunities that are derived from STEM education were also examined. The finding of this study indicate that there are many opportunities that emanate from STEM education and most of the first year Commerce students professed ignorance of the benefits from STEM education. Due to little knowledge of the STEM subjects and STEM jobs there is completely very low passion to pursue careers aligned to STEM education by Commerce students. In general, the educational system is not adequately preparing graduates to meet the demands of science and technology, whether in the public or the private sector. It is also established that the educational system is not able to meet current knowledge and skill requirements of the technology sector. This might have been aggravated by the fact that resources are lacking in most every aspect of education, including insufficient numbers of qualified teachers of mathematics and science at the primary- and secondary-school level, inadequate equipment and materials, textbooks and facilities (i.e., laboratories and libraries).

### 4.1 Employment creation

It came out of the study that STEM education results in employment creation. Student participants echoed that skills from stem education will enable students to acquire practical scientific and technical skills and knowledge that help them to sustain individual livelihood. This was found to be possible only when one has adopted STEM subjects. It also emerged that stem subjects equip students with hands on skills which allow any other person to depend upon and contribute to employment creation. The lecturers who participated in the group interviews underscored that despite the fact that STEM education is new in Zimbabwe it has job guarantee that ides in the building of our economy. More benefits of stem education were highlighted despite the high level of ignorance in the concept. It was further agued that the little support and push for stem education by the government and stakeholders paints an opaque picture and students may hardly give value to appreciate opportunities from stem education.

### General opportunities from stem education

***Table 1 Ranking opportunities from STEM education=38***

| | |
|---|---|
| 1.Attractive salary | **90%** |
| 2.Entrepreneurship | **80%** |
| 3.Creativity | **75%** |
| 4.Development of intellectual mind set | **70%** |
| 5.Discovery learning | **65%** |

**Source: Field Survey 2016**

STEM education is rated highly for bearing opportunities that contribute to good jobs with attractive salaries 90% Innovation or creativity has been noted to rank 75% thus a clear message to say stem workers contribute to

the development of valuable ideas and inventions 70%, and these STEM workers make the commercialization of those ideas and inventions feasible and profitable in their life career. The statistics above indicate that there are fortunes that students may enjoy out of doing stem subjects at some point now or in the future. It is apparent that enhancement of entrepreneurship 80%, skills is one of the most important benefit from stem education. Comments of varying lengths were made by some students.

> *"STEM education if put right is a beacon of hope in Zimbabwe. It is good for us to foster the ten point plan, Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZIMASSET)."*
>
> *"We have great passion to do Stemtisation but we are not quite clear as to how much benefit would this change improve our future."*
>
> *"With ZIMASSET you are the employer a boss of yourself and we hope through the stem subjects we would be empowered to create our own things, life and prepare our own future."*
>
> *"Have our unique knowledge, skills and competencies to earn a living."*

The above statements illustrate positive views about stem education but it seems there is lack of information on the opportunities. Publicity of stem education needs further clarification in order to promote its adoption. During the time of this study the perception of the respondents are more informed on factors inhibiting adoption of stem education than condoning opportunities from stem education.

One lecturer commented that *"STEM education can deepen the understanding of concepts by presenting them in a real-world context."* From these comments stem education enhances contextual understanding of concepts. Thus the element of hands on enables the learners to translate theory components to practical reality. It is therefore critical to emphasize the importance of STEM education to students to prepare their world of work through it. So, polytechnic institutions can redesign their curriculum to meet the needs of the learners through Stemtisation of courses. Reddan and Harrison (2010) claimed that TVET institutions need to restructure their programmes to be responsive to the needs of the job and job market only.

## 4.2 Factors affecting adoption of STEM education

### 4.2.1 Curriculum issues

From the evidence of this research it would appear that factors affecting STEM adoption are there and the need to remove these barriers is taking long to restore confidence in students, parents and stakeholders. The curriculum was designed to discriminate students according to class performance. Students felt that the most disadvantage to the adoption of STEM education emanate from the comments from teachers. The plight of poverty stricken students is exasperated by stringent school policies that pertain the learning environment, attitudes by teachers and fellow students, (Moyo, 2013). The prevalent of unsupportive learning climate is not conducive to nurture the students' zeal to learn new things. The following comments were made during the focus group discussions.

> *"All those not doing pure science should not land their feet in form three "A". Integrated Science can accommodate you in form three C & D."*
>
> *"We feel embarrassed and feel that we do not deserve to do that pure science subject. We are labelled as incompetent. We thought STEM education is meant to develop skills across all disciplines."*
>
> *"We wonder whether the teachers also understand STEM education so it is difficult to adopt this education phenomenon."*

During the time of the study students lamented on the attitude of teachers to students who may not be sharp in Science and quickly the element of labelling students destroyed the interest in stem subjects. Fischer & Hout (2006) opines that Science always requires education, but education does not have to be scientific. Basically, poor attitude on stem education discredit the adoption of the education change.

### 4.2.2 Lack of qualified stem teachers

The lecturers also echoed that students are not well prepared to develop a positive interest in stem education. The discussion ensued that there are no qualified teachers to teach stem education. Zimbabwe still has a shortage of Science and maths teachers especially in rural areas. Furthermore, it may be apparent that access to school completion is difficult particularly in poor rural communities. So the preparation of students for

postsecondary education is inadequate and would eventually affect career choices to adopt stem education in polytechnics. One first year commerce student emphasised that "I think the education system Primary and secondary lacks capacity of the educational system to produce qualified graduates in science and technology—those who posses the knowledge, skills and competencies to meet current and future demands."

**4.2.3 Lack of resources**

Both the views from the focus group and interviews concurred that there are lack of resources in pre-postsecondary education needed to prepare students to face the world of employment in their future career choices. It is highlighted that some remote schools have a horde of problems from lacking qualified staff to shortage of text books and poor infrastructure and totally absence of science laboratories. "*It is one of the reasons why the curriculum in certain schools is manipulated and left to teach integrated science only. The product of this subject will not take medical field or pure engineering courses as career path*," says one lecturer. In Zimbabwe, the need for educational reform to meet the demands of the 21st century workplace, particularly in science and technology, cannot be over emphasized. Schools must help students to become skilful manipulators, synthesizers, and creators of knowledge. Chisholm (2005:87) argues that the curriculum change can be implemented with ease in well-resourced contexts possessing well trained educators. The absence of well trained teachers and resources say necessary to articulate a successful laboratory experiment stifles the whole learning atmosphere. The study's participants chronicled the poor preparations and sometimes chaotic learning environments. One student female interviewee had these remarks, *"Honestly speaking, we did not learn any stuff to help us go for engineering courses. Besides, traditionally stem subjects or courses were always for men and the orientation right at the college is not enough and clear so we feel we cannot venture into grey areas"* As a result lack of deep and coherent understanding of the subject matter may also limit their entry into engineering where stem subjects are more enshrined for instance, the ability to design and use higher order thinking skills as needed by constructivist approach in teaching of science.

## 4.2.4 Attitude and students' background

It emerged in this study that students do not want to take up stem subjects because of the attitude inherited in families and society. Some male students confirmed that their passion is to pursue white colar jobs. This tries to imply that right from the dawn of Zimbabwe independence to date the settler colonial hangover is still dogging our youth. Apparently, it may seem to say that the students' minds sets are still locked to colonial mentality of white colar jobs and the need for mental decolonisation is long over due. The results of the study further implicated present career choices to their background. One female student says, *"We grew up being encouraged to become teachers, nurses, medical doctors but not engineers or mechanics. Currently, some parents share the view that stem subjects are for males and the stem jobs are just but too risky, besides the training is expensive, challenging and laborious*."

While there were mixed views of religion the study participants have shown that some denominations do not approve women to wear trousers because it is condemned regarding issues of indecency and immorality in Zimbabwe. Where as some sentiments were that females want to dress formally rather than be in a work suit and safety shoes. Such factors have been highlighted as barriers to do stem education courses. Basically the participation of parents in the education of their children is inconsistent due to attitude, poverty and low socio-economic status as observed by some lecturer-respondents. Martin (2003) reported that some parents do not participate in their children's school activities because they feel that it is not their job or that they have no interest because of attitudes or beliefs.

**Figure 4.0 showing other factors stifling adoption of stem education.**

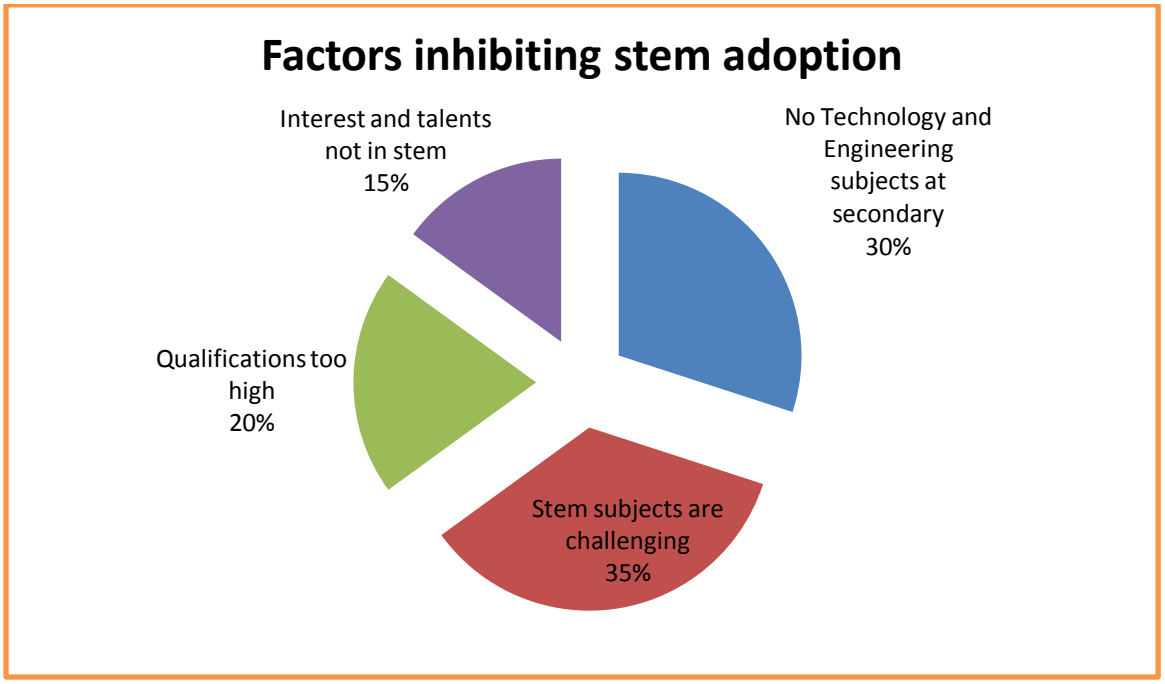


**Fig 4.0 illustrating factors stifling adoption of stem education from students.**
**Source: Field Survey 2016**

From the findings, interest and talents are not only tailored to stem education 15%. Lack of entry qualifications account for 20%, while the reasons that Engineering and Technology subjects are not taught at secondary level 30%, account as other factors that hinder adoption of stem education by first year Commerce students in polytechnics. The other factor which says stem subjects are challenging ranks high with 35% of other identified factors. There is need of some form of rationalising our education to make it meaningful and even accessible to its users. It is very unlikely that educators need students to pass STEM subjects when some of the subjects do not even feature in the secondary curriculum. It seems that STEM education is coming to the people from an upper level not from a lower level. This makes it difficulty for learner and educator who might have obtained her/his qualifications under the old curriculum might not have adequately prepared her/him to handle the new curriculum. A recent study by Kumpulainen et al. (2011) showed that lack of understanding of teaching methodologies among educators and researchers was a setback to social interaction in learning and instruction.

## V CONCLUSIONS

In conclusion, there are numerous opportunities from taking stem education up to employment level despite the low understanding of stem education found among the first year Commerce students in polytechnics. Stem workers command high salaries, STEM degree holders enjoy higher earnings, regardless of whether they work in STEM or non-STEM occupations. Stem education increases creativity, critical thinking, innovation and discovery learning. Equally important, workers in STEM jobs tend to experience lower unemployment rates than workers in other fields. However, the factors that impact on the adoption of stem education are multifaceted. There are those that are educator centred, parental, religious, curriculum related, student centred, policy, resources, institutional and environment centred. Besides that, there are factors that are associated with failure on the part of the government to provide needed resources timely to kick start STEM education by in large. In addition the study also noted the shortfall of adequate qualified teachers to stem subjects, lack of preparation for postsecondary stem study, failure to meet stem job needs and failure to motivate student interest in stem subjects.

## VI RECOMMENDATIONS

- All students in all schools must be a part of the STEM vision and teachers must be provided with the proper professional development opportunities that will enable them to guide all their students toward acquiring STEM literacy (Crow, Kennedy, Odell, Ophus & Abbitt, 2013).

- Technology and Engineering subjects have to be integrated into the culture, curriculum, teaching strategies and daily operations of classrooms to enhance learning and provide relevance to stem education.
- Provide opportunities to connect STEM educators and their students with the broader STEM community and workforce.

- Collaborations among stakeholders in education, government, business, the community, and the media should be encouraged to coordinate the development and availability of STEM educational resources.
- Increase community understanding of STEM education to prepare students for work and life in the 21st century.
- Increase student 21st century skills and technology literacy by providing use of the technical tools of the STEM industry.
- Increase the number of students pursuing careers in STEM-related fields and/or postsecondary STEM-related education/training.
- Extensive marketing of the stem education must start from primary education to university level.

This study therefore shares the view from this study's participants that there is need for a national survey on the opportunities and factors that affect adoption of stem education in polytechnics by commerce students. The study will enable to generalise the findings on a national level.

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