

STEM Education Teaching Approach and Secondary School Students Learning in the Buea Municipality

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Abstract: This study is aimed at analyzing the impact of STEM education teaching approach on secondary school students in Buea Municipality South West Region of Cameroon. Four specific objectives guided the study. The descriptive survey research design was used in conducting this study with a sample size of 60 with the instrument for data collection being the questionnaire. The random sampling technique was employed and data collected was analyzed using inferential statistics. The findings of the study revealed a positive effect of certified STEM education teachers, STEM equipment and facilities; STEM teaching methods and assessment strategies; and time allocation on students learning.

Keywords: STEM Education Teaching Approach Students Learning

Introduction

STEM education promotes the integration and development of scientific and technical subjects in an inter and multi-disciplinary approach. It is concerned with equipping students with critical thinking and problem solving, knowledge skills and attitudes. STEM education according to Satchakett & Thana (2019) and Williams (2019) is an integration of integrated teaching across disciplines with an emphasis on interdisciplinary teaching approach, with focus on STEM – Science, Technology, Engineering and Mathematics. Kunalan et al (2018) is of the view that STEM education is derived from research, and elaborates on the implications of their application. Its practical learning through real-world projects prepares the students based on combining formal and informal activities, to improve learners' interest in learning and increase their participation (Williams 2019; Wang & Chiang, 2020). STEM education according to Kazu & Kurtoğlu (2021) equips learners with 21st-century skills based on the integration of science, technology, engineering, and mathematics as a teaching approach. Investing in the advancement of technology through STEM education approach focuses on the development of a highly skilled workforce for today and future society.

Review of Literature

STEM education according to Hasanah (2020), is discipline which needs a teaching workforce that is knowledgeable and skillful because most of the initiatives in STEM education would be related to the disciplines. In this study, the indicators of STEM education are certified STEM teachers; STEM equipment and facilities; teaching methods and assessment strategies; and time allocation for STEM education.

STEM education accelerates student learning, increases confidence and ability in using technology. Supports all students' needs, regardless of starting point. 21st century skills are highly valuable for students' future careers. Kazu & Kurtoğlu (2021) are of the view that science and technology have shaped the educational system and what the future holds for both the individual and the society. STEM education is an important process which will make the educational system to be abreast with developmental processes and societal expectations. STEM education is therefore of critical importance as it is the key to technological development and innovation. Among the transferable skills developed through STEM education are computational thinking, coding, design thinking, innovating, use of the scientific method, scientific inquiry skills, and engineering design skills. Çepni

(2017) and Kunalan et al (2018) opined that these skills are in high demand in today's globally connected world, there is the need for appropriate and adequate teaching of STEM subjects.

Teaching method: STEM education is taught using an interdisciplinary approach since it a combination of disciplines. It therefore requires the use of knowledge, skills and methods from many disciplines and fields of study. (Wang & Chiang 2020; Ayverdi & Öz Aydın 2020). Students learning outcomes and achievements generally is due to the teaching methods and strategies teachers use in the teaching learning process and in STEM education specifically. The use of learner - centred teaching method for STEM education is essential in other for learning experiences revolve around the learner. STEM education strategies can be incorporated into different teaching-learning approaches. Some of the teaching-learning strategies and methods used in STEM education include the project-based approach, problem-based learning and inquiry approach. (Craig, & Marshall, 2019; Çevik, 2018; Sutaphan & Yuenyong, 2018). This enables the learner to be co-producers of learning hence retain knowledge skills and attitudes acquired better. When STEM is effectively taught, using methods such as Problem-Based Learning (PBL); Inquiry-Based Learning (IBL) and critical thinking, students are able to develop, problem solving, skills and work independently as well as in teams.

Problem-Based Learning (PBL) is a method of teaching which requires high level thinking. Many author Yew & Goh (2016); Azril et al (2021); and Trullàs et al. (2022) have defined it as a learner centred strategy where the learners work in small tutorial groups, engage in hands-on training and tackle real-life challenges. It is an active way of learning that enhances retention of knowledge, motivation and encourages skills development which are essential for professional life. PBL makes it possible for learners to be innovative, creative, open-minded, and logical. Students analyse, create and evaluate a problem posed. In Problem-Based Learning, students learn through experience by solving open-ended problem which makes them to be creative, innovative, and develop critical thinking skills (Wirantaka & Sukarno, 2022). During the PBL process, the students learn how to create stimulating learning situations through their PBL statement and carry out hands – on activities which results in student learning. The teacher becomes the tutor who acts as a facilitator promoting autonomous learning.

Inquiry-based learning (IBL) is an active learning method that encourages students to use questioning and exploration to investigate real-world problems. It is a structured teaching method and flexible in its practice. It is an approach to learning that encourages students to engage in problem-solving and experiential learning. This teaching approach is student-centred and encourages them to engage in critical thinking by creating connections between the information gathered in the classroom and their daily reality experiences. Inquiry-based learning is rooted in the constructivist philosophy which according Toma et al (2024) states that personal and societal experiences influence how human beings gather and make meaning of information. The teacher need to focus the learners on the purpose of using inquiry-based learning since they may not be conversant with the use of inquiry-based learning. Students need to learn how to develop ideas, generate questions for themselves and their group members in a constructive manner Sitti et al (2021). They also have to investigate ideas and hypotheses; Use guided inquiry - open question they design investigation methods to reach a conclusion. Sweetland & Towns (2008) are of the view that students could also be allowed to use open inquiry where they are given time and support to pose original questions that they investigate through their own methods, and eventually present and discuss their results to expand.

Certified Teachers: These are teachers who has earned credentials from an authoritative source, such as the government, a higher education institution or a private body or source. This teacher qualification gives a teacher authorization to teach and grade in pre-schools, primary or secondary education in countries, schools, content areas or curricula where authorization is required Berliner (2001). According to Sass (2011), individuals complete a program of study in a university-based teacher preparation program in order to be licensed to teach. A teacher is a person who helps others to acquire knowledge, competences or values. Teachers are the most important components in the event education of students. Boyd et al (2007), is of the view that teachers who go through a certification process and score well on certification exams can improve student outcomes somewhat. Limbong & Lumbantoruan (2022) define teacher certification as a form of a competency test designed

as the basis for awarding certificates and incentives for teachers and lecturers. The purpose of teacher certification according to Hanushek & Woessmann, (2020) is to improve the quality of teacher's work which results in improved performance and competence to contribute in increasing the quality of education especially for STEM education teachers.

The Concept of Time Allocation

The amount of time allocated for learning and the way that time is used in STEM education is of great importance. It is also known as academic learning time. Brodhagen & Gettinger (2012) defines it as the amount of time students are actively, successfully, and productively engaged in learning relevant academic content. Learning time can, be allocated, organized, and modified to enhance learning opportunities for students. Howard (2009); (Gerwertz, 2008) & Gallardo et al., (2016). According to Berliner (2021), there are several types of time: Allocated time is the time that the school, or teacher provides the student for instruction. Engaged time is defined as the time that students pay attention to materials and presentations that have instructional goals. It is also known as attention time. Time-on-task is engaged time on particular learning tasks. Academic learning time is that part of allocated time for the subject-matter area where the student is expected to engage in the activities/ materials which they are exposed to. It includes concepts such as allocated time (amount of time provided for the task); time-on-task (engagement in tasks that are related to outcome measures or evaluation instruments in use); and success rate (the percent of engaged time that a student is experiencing a high success experience in class). Transition time is the non-instructional time before and after some instructional activity. Waiting time usually defined as the time that a student must wait to receive some instructional help. Pace is defined as the amount of content covered during some time period (Berliner, 2021); (Brodhagen & Gettinger 2012).

The concept of equipment and facilities for learning

Many authors have written on the concept of school equipment and facilities. Nnabuo et al (2008); Musa (2012); Akpabio (2015); Uzochukwu (2023). The term "school facilities" is the area dedicated to students for use. faculty, or administrative or maintenance personnel for clinical purposes, research activities, libraries, classrooms, offices, auditoriums, dining areas, student activities, or other related purposes necessary for, and appropriate to, the conduct of

comprehensive programs of education. Such term includes interim facilities but does not include off-site improvements or living quarters. School facilities management is an integral part of the overall management of the school. The physical environment of a school is a major determining factor in the attainment of its objectives (Garton 2006). School facilities give meaning to the teaching and learning process, and recommends that school managers should carry out comprehensive assessment of the facilities to determine areas of need. The primary purpose of teaching and learning is to bring about in the learner desirable change in behaviour through critical thinking. This process does not take place in a vacuum but rather in an environment structured to facilitate learning. In support of this, Nnabuo, Okorie and Agabi (2008) submitted that the actualization of the goals and objectives of education require the provision, maximum utilization and appropriate management of school facilities. Educational management is the totality of efforts that are brought to bear in the provision and delivery of education to ensure that both human and material resources allocated to education are used to the best advantage in the pursuit of educational goals and objectives. Facilities management is an integral part of the overall management of the school. The physical expression of the school curriculum in the construction, internal and external arrangement of facilities, equipment. It is line environment, facilities, equipment and buildings in which teaching and learning take place Uzochukwu (2023). School facilities management according to is the practice of careful utilization and control of available material resources in the school system. It involves the process of directing, coordinating and modifying materials towards the achievement of organizational goals.

Theoretical Review

Constructivist theory otherwise known as constructivism, is a learning theory that states that learners construct new meanings and understanding by integrating new information with prior

knowledge Pritchard & Woollard (2010). In a constructivist classroom setting, the teacher acts more like a facilitator, and the students are active participants in the learning process. The students are encouraged to interact and exchange their thoughts and opinions, allowing them to co-construct new knowledge.

Constructivism theory and STEM education have a close relationship. Constructivism theory emphasizes that learning occurs when learners construct their own knowledge and understanding. It states that teachers should create an effective learning environment and assist learners in constructing knowledge. STEM education, according to Tenney et al (2023) promotes active learning and engagement. It encourages students to construct their own understanding through hands-on activities and problem-solving. Research Changyan Di, et al (2021); Toma et al (2024). suggests that constructivist teaching and learning environments play a central role in boosting success for students in STEM fields. By incorporating constructivist pedagogy, educators can improve learning and achievement for all students in STEM education ^[1]. The Montessori pedagogical system, which is based on constructivism, also shares common features with the STEM approach.

Objectives of the Study

Specifically, the objectives of the study is to find out:

- The effect of certified teachers on the teaching and learning of STEM education
- The effect of equipment and facilities for teaching and learning of STEM education
- The effect of teaching methods and assessment strategies on the teaching and learning of STEM education
- The effect of time allocation on the teaching and learning of STEM education

Research Hypothesis

The following hypothesis were formulated to guide this study

- Ha₁: Certified teachers have significant effect on the teaching and learning of STEM education
- Ha₂: Equipment and facilities have significant effect on the teaching and learning of STEM education
- Ha₃: Teaching methods and assessment strategies have significant effect on the teaching and learning of STEM education
- Ha₄: Time allocation has a significant effect on the teaching and learning of STEM education

Methodology

The research design of this study is the descriptive research design while the population of the study constitutes all the secondary school students in Buea Municipality. Using the simple random technique, a sample of 60 was realized for the study. The instrument for data collection in this study was a 4 point Likert scale: SA-Strongly Agree, A-Agree, D-Disagree, and SD-Strongly Disagree. SPSS Data Package was used for data analysis for inferential statistics (one-sample t-test). The hypotheses were tested at 0.05 level of significance.

Presentation and Discussion of Findings

Table 1: Certified teachers

STATEMENTS	SD		D		A		SA	
	F	%	F	%	F	%	F	%
Certified teachers acquire professional certificates	5	8.3	5	8.3	26	43.3	24	40.0
Teachers should structure educational environments	5	8.3	10	16.7	26	43.3	19	31.7
Teachers teach based on their qualification	4	6.7	0	0.0	31	51.7	25	41.7
A teacher helps others to acquire knowledge	2	3.3	2	3.3	26	43.3	27	45.0

To obtain more information concerning the independent variables, the following statements were made about certified teachers and the results were as follows: First statement "certified teachers acquire professional certificates". Responses on this statement were; 5(8.3%) strongly disagreed; 5(8.3%) disagreed 26(43.3%) agreed and 24(40%) strongly agreed that certified teachers acquire professional certificates. Second statement: "Teachers should structure educational environments" 5(8.3%) strongly disagreed 10(16.7%) disagreed 26(43.3) agreed and 19(31.7%) strongly agreed to the fact that teachers should structure educational environments. The third statement " teachers teach based on their qualification" 4(6.7%) strongly disagreed, no one disagreed that teacher's teach based on their qualification. 25(41.7%) agreed and no respondent strongly agreed that teach based on their qualification. Fourth statement "A teacher helps others to acquire knowledge" responses were as follows; 5(8.3%), 2(3.3%) disagreed 26(43.3%) agreed and 27(45%) strongly agreed that a teacher helps others to acquire knowledge. and facilities

Table 2: Equipment and facilities

STATEMENTS	SD		D		A		SA	
	F	%	F	%	F	%	F	%
Libraries should be equipped with relevant textbooks	0.0	0.0	1	1.7	37	61.7	22	36.7
Audio-visuals help teachers to display videos, images and audio files	3	5.0	5	8.3	26	43.3	26	43.3
There is the need for more Lab equipment	3	5.0	3	5.0	27	45.0	27	45

No respondent strongly disagreed that libraries should be provided with relevant and updated text books for students 1(1.7%) disagreed; 37(61. %) agreed and 22(36.7%) strongly agreed. 3(5%) of the respondents strongly disagreed that audio visuals helps teachers to display videos, images and audio files, 5(8.3%) disagreed, 26(43.3%) agreed, and 26(43.3%) strongly agreed that audio visuals help teachers to display videos, images and audio files. 3(5%) of the respondents strongly disagreed that there is the need for more laboratory equipment. 3(5%) of the respondents disagreed, 27(45.0%) agreed, and 27(45.0%) strongly agreed that there is the need for more laboratory equipment

Table3: Teaching methods and assessment

STATEMENTS	SD		D		A		SA	
	F	%	F	%	F	%	F	%
Teachers should demonstrate and illustrate when teaching	0	0.0	1	1.7	34	56.7	25	41.7
Teachers should use lecture discussion method when teaching	1	1.7	5	8.3	28	46.7	26	43.3
Hands-on activities or practical are very important to students	1	1.7	1	1.7	30	50.0	28	46.7
Teachers should use observation and problem solving methods to teach	0	0.0	0	0.0	30	50.0	30	50.0
Teacher's qualification gives them authorization to evaluate	0	0.0	3	5.0	31	51.7	26	43.3

From table 3 above, no respondent strongly disagreed, that teachers should demonstrate and illustrate when teaching, 1(1.7%) disagreed; 34(56.7%) agreed and 25(41.7) of the respondents strongly agreed. 1(1.7%) strongly disagreed that teachers should use lecture discussion method when teaching 5(8.3%) disagreed; 28(46.6) agreed; while 26(43.3%) strongly agreed, 1(1.7%) of the respondents strongly disagreed, 1(1.7%) disagreed; 30(50%) agreed and 28(46.7%) strongly agreed. None of the respondents, 0 (0%) strongly disagreed that teachers should use observation and problem solving methods to teach, no respondents 0 (0%) disagreed; 30(50.0%) agreed and 30(50.0%) of the respondent strongly agreed. No respondents 0(0.0%) strongly disagreed that teachers' qualification gives them authorization to evaluate; 3(5%) disagreed; 31(51.7%) agreed.

Table 4: Time allocation

STATEMENTS	SD		D		A		SA	
	F	%	F	%	F	%	F	%
Time is a resource just like infrastructure and personnel	0	0.0	2	3.3	32	53.3	26	43.3
Time has to be properly managed	0	0.0	1	1.7	44	73.3	15	25
Academic learning time ensures that work is done in time	1	1.7	1	1.7	31	51.7	27	45
Students should be given enough time to perform a particular task	1	1.7	3	5.0	28	46.7	28	46.7

Table 4 above, deals with the effect of time allocation on teaching and learning. No response for strongly disagreed with a zero percent 0(0.0%) that time is a resource just like infrastructure and personnel, 2(3,3%) disagreed 32(53.3) agreed and 26(43.3%) strongly agreed. No respondent strongly disagreed 0(0.0%), that time has to be properly managed. 1(1.7%) disagreed, 44(73.3%) agreed. 1(1.7%) strongly disagreed that academic learning time ensures that work is done in time. 1(1.7%) disagreed, 31(51.7%) agreed and 27(45%) strongly agreed. 1(1.7%)of the respondents strongly disagreed that students should be given enough time to perform a particular task, 3(5%) disagreed, 28(46%) agreed, and finally, 28(46.7%) strongly agreed that students should be given enough time to perform a particular task.

Inferential statistics: One-sample t-test

Table 1: Testing H₀₁, at p=0.05

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Certified Teachers	-1164.714	59	.000	-116.80000	-117.0007	-116.5993

Table 1 presents a one sample t-test results for the H₀₁. At a degree of freedom (df) of 59, the table gave a t-value of (-1164.714), with a mean difference of -116.80000 and at the same time a p-value of 0.00, p<0.05. H₀₁ was therefore rejected and H_{a1} was retained, implying that, certified teachers have significant effect on the teaching and learning of STEM education in Buea municipality.

Table 2: Testing H₀₂, at p=0.05

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Equipment and Facilities	-1355.470	59	.000	-116.70556	-116.8778	-116.5333

Table 2 shows a one sample t-test results for the H₀₂. At a degree of freedom (df) of 59, the table shows a t-value of (-1355.470), and a mean difference of -116.70556. The table also presented a p-value of 0.00, p<0.05, hence H₀₂ was rejected and H_{a2} was retained. Therefore, implying that equipment and facilities have significant effect on the teaching and learning of STEM education in Buea municipality.

Table 3: Testing H₀₃, at p=0.05

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference
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					Lower	Upper
Teaching Methods and Assessment	-1619.046	59	.000	-116.59667	-116.7408	-116.4526

Table 3 presents the results for one sample t-test of H_{03} . From the table, at a degree of freedom (df) of 59, the table provides a t-value of (-1619.046), with a mean difference of -116.59667. The table further gives a p-value of 0.00, $p < 0.05$, implying that H_{03} was rejected and H_{a3} was accepted. It can thus be concluded that, teaching methods have significant effect on the teaching and learning of STEM education in Buea municipality.

Table 4: Testing H_{04} , at $p=0.05$

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Time Allocation	-1793.008	59	.000	-116.65000	-116.7802	-116.5198

Table 4 also presents a one sample t-test results for the H_{04} . At a degree of freedom (df) of 59, the table gave a t-value of (-1793.008), and a mean difference of -116.65000. Going further, the table shows a p-value of 0.00, $p < 0.05$. Based on the results, H_{04} was rejected and H_{a1} was maintained. Therefore, it was concluded that time allocation has a significant effect on the teaching and learning of STEM education in Buea municipality.

Discussion

The main objective of this study was to study the impact of STEM education teaching approach on students learning in the Buea municipality. The result shows the effect of certified teachers on secondary school students learning is statistically significant at a t-value of (-1164.714), with a mean difference of -116.80000 and a p-value of 0.00, $p < 0.05$. The results revealed positive effect of the use of equipment and facilities for STEM education teaching approach on students learning. This implies that equipment and facilities have significant effect of STEM education teaching approach on students learning in Buea municipality is statically significant at a t-value of (-1619.046), with a mean difference of -116.59667 and a p-value of 0.00, $p < 0.05$. Teaching methods also has a significant effect of STEM education teaching approach on students learning in Buea municipality. The effect of time allocation using STEM education teaching approach on secondary school students learning is statistically significant at a t-value of (-1793.008), and a mean difference of -116.65000. Many research findings (Garton 2006); Nnabuo, Okorie and Agabi (2008); (Brodhagen & Gettinger 2012). (Berliner, 2021); Limbong & Lumbantoruan (2022) Tenney et al (2023); Uzochukwu (2023) are in agreement with these findings.

Conclusion

This study titled the impact of STEM education teaching approach on secondary school students learning in the Buea municipality was carried out and the findings of the study revealed positive effect of certified STEM education teachers on students learning. STEM equipment and facilities also had a positive effect on students learning in the Buea municipality. Thirdly, teaching methods also has a significant effect of STEM education teaching approach on students learning. The fourth and last hypothesis was correct since time allocation also had a positive effect on students learning. It can therefore be concluded that there is an impact of STEM education teaching approach on secondary school students learning in the Buea municipality.

Recommendations

After the research work which looks at the impact of teaching and learning integrated science on junior secondary school students in the Buea Municipality

It is recommended that management of schools should recruit certified teachers to enhance the teaching and learning process of the students

It is also recommended that schools should be more intentional about time allocation and

management as it is a vital element to push up students learning

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