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The effectiveness of teaching methods on skill acquisition in STEM education in some primary schools in Yaoundé VI subdivision

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DEDICATION

To my beloved parents.

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CERTIFICATION

We hereby certify that this dissertation title: **the effectiveness of teaching methods on skill acquisition in STEM education in some primary schools in Yaoundé VI subdivision"** submitted to the Department of Curriculum and Evaluation, Faculty of Education in the University of Yaoundé 1 was carried out by Anonda Larissa Nyoh registration number 22V3820 of University of Yaoundé I, Faculty of Education, department of Curriculum and Evaluation. The work has been properly referenced and acknowledged.

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Dr. SHAIBOU HAJI ABDOULAI	Prof. MAINGARI DAOUDA
_____	_____

ABBREVIATIONS

ETSSP:	Education and Training Sector Strategy Paper (ETSSP)
ETSSP:	Education and Training Sector Strategy Paper.
F.S.L.C:	First School Leaving Certificate
G.B.P.S:	Government Bilingual Primary School
GESP:	Growth and Education Strategy Paper.
Ha:	Alternate Hypothesis
Ho:	Null Hypothesis
IBL:	Inquiry Based Learning
ICT:	Information and communication technology
M.K.O:	More knowledgeable Order
MINEDUB:	Ministry of Basic Education
NSES:	National Science Education Standards
PBL:	Problem Based Learning
PjBL:	Project Based Learning
RQ:	Research Question.
S.M.E.T:	Science Mathematics, Engineering, Technology
SDGs:	Sustainable Development Goals.
STEM:	Science, Technology, Engineering and Mathematics.

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ABSTRACT

The study titled the effectiveness of teaching methods on the acquisition of skills in STEM education in some selected primary schools in Yaoundé VI subdivision. This study reviews the current research on the effectiveness of different instructional approaches in STEM education. The main objective of the study is to verify the effectiveness of teaching methods on skill acquisition in STEM education in some primary schools in Yaoundé VI subdivision. The main research hypothesis states that teaching methods have an effect on skill acquisition in stem education in some primary schools in Yaoundé VI subdivision. The teaching methods used for the study included project-based method, problem-based method and inquiry-based method. The STEM skills which serve as the dependent variable which are measured are critical thinking, problem solving, creativity and collaboration. The study was guided by four research questions. It used the descriptive survey research design and the data for this study was collected using closed ended questionnaire made up of 26 items. Four likert scale items weighting 1_4 were used for the study. The reliability of the data collection instruments were tested using alpha cronbach during a pilot study and it gave a figure of 0.89 indicating high reliability. The questionnaire was reviewed by the candidate's supervisor to ensure validity. The study had a population of 95 teachers and a sample of 76 participants. The study used 10 schools and their teachers using purposive sampling. The data was analyzed using SPSS version 21. Data was presented in terms of frequencies, percentages and figures on different tables. The results suggest that active teaching methods all fostered skill acquisition in in STEM education in Yaoundé VI subdivision with more priority on project-based learning. The study equally found out that if the other teaching methods are properly implemented there will go a long way to foster skill acquisition as they had a significantly moderate effect on the dependent variable. The study reviewed the constructivist theory of learning. It recommends that educators, policy makers, curriculum developers should adopt favorable policies especially learner centered approaches towards STEM education and equally provide resources to ensure its success. The study suggests that a similar study should be carryout involving primary schools in Mfoundi division for better generalization of results.

Keywords: *teaching methods, STEM education, STEM skills, project base learning, inquiry base learning.*

RESUME

L'étude a intitulé l'efficacité des méthodes pédagogiques sur l'acquisition de compétences en éducation STEM dans certaines écoles primaires sélectionnées de l'arrondissement de Yaoundé VI. Cet article passe en revue les recherches actuelles sur l'efficacité comparative de différentes approches pédagogiques dans l'enseignement STEM. Les méthodes d'enseignement utilisées pour l'étude comprenaient la méthode basée sur le projet, la méthode basée sur les problèmes et la méthode basée sur l'enquête. Les STEM qui servent de variable dépendante mesurée sont la pensée critique, la résolution de problèmes, la créativité et la collaboration. L'étude était guidée par quatre questions de recherche. Il a utilisé le plan de recherche de l'enquête descriptive et les données de cette étude ont été collectées à l'aide d'un questionnaire fermé composé de 26 éléments. Quatre éléments de l'échelle de Likert ont été utilisés pour l'étude. L'étude portait sur une population de 95 participants et un échantillon de 76 participants. L'étude a sélectionné 10 écoles et leurs enseignants à l'aide d'un échantillonnage aléatoire simple. Les données ont été analysées à l'aide de l'analyse de corrélation et de régression du moment du produit de Pearson pour vérifier l'hypothèse de l'étude. La version 21 de SPSS a été utilisée pour analyser les données. Les données ont été présentées en termes de fréquences, de pourcentages et de chiffres dans différents tableaux. Les résultats suggèrent que les méthodes d'enseignement actif ont toutes favorisé l'acquisition de compétences dans l'enseignement STEM dans l'arrondissement de Yaoundé VI, avec une plus grande priorité sur l'apprentissage par projet, car les résultats ont prouvé qu'elles sont appliquées dans toutes les écoles sélectionnées pour l'étude. Si d'autres méthodes d'enseignement sont correctement mises en œuvre, elles contribueront grandement à favoriser l'acquisition de compétences, car elles ont un effet de 50 % sur la variable dépendante. L'étude recommande que les éducateurs, les décideurs politiques et les concepteurs de programmes d'études adoptent des politiques favorables à l'enseignement STEM et fournissent également des ressources pour assurer son succès.

***Mots clés** : méthodes d'enseignement, éducation STEM, compétences STEM, méthode de base de projet, méthode de base d'enquête.*

CHAPTER 1
INTRODUCTION

Education in the 21st century has shifted from the teacher centered approach to a learners centered approach aim at molding learners who possess 21st century skills such as creativity, critical thinking, collaboration, communication, problem solving and digital literacy (Gradini, 2019).. In this light there's a massive campaign on adopting teaching strategies and methods that will facilitate the acquisition of these skills as well as educational disciplines that will mold learners to suit the 21st century demands. This has brought to lamplight global awareness and interest on STEM (Science, Technology, Engineering, and Mathematics) education by researchers, teachers, curriculum developers and the educational community as a whole in recent times. STEM education is an integrative approach to teaching and learning science, technology, engineering and mathematics. (Tallar, 2022).

Educators suggest that there's need for emphasis to be placed on STEM education as early as the elementary level so as to inculcate in the learners interest in stem education as early as possible as well as develop in them the necessary skills (Yelland, 2019).STEM education in the early years provides a context for designing active learning ecologies that connect with children's natural curiosity about their world. It engages children in authentic investigations, using critical and creative thinking in systematic ways to build knowledge, acquire skills and cultivate confident dispositions for learning. (Tallar, 2022).

Early childhood education prepares children with the skills they need to build knowledge in the later stages of education. The period between infancy and the third grade is critical to developing STEM-related thinking dispositions such as curiosity, inquiry, assessment, and analysis. STEM education provides children with contextualized and authentic real-life contexts to observe, investigate, and collaborate with others to solve meaningful real-world problems (Yelland 2019).

Teaching at any level is to bring fundamental change that will facilitate the process of knowledge transmission in the leaners. At this instance, teachers should apply appropriate teaching methods that would best suit objectives and learning outcomes. In the traditional era where teaching and learning gain more much development, many teaching practitioners applied widely teacher centered methods to impart knowledge to learners. Until today, questions about the effectiveness of teaching methods on students' academic performance have raised

considerable interesting the field of educational research. Moreover, research on teaching and learning constantly endeavor to examine the extent to which different teaching methods enhance growth in students learning (Ekanem, 2016)

The success of teaching lies mainly on the knowhow of the subject involve and the use of appropriate teaching methods that is required per time during the transfer of knowledge. A skillful and competent teacher uses as many methods and techniques as possible because there is no single method which is regarded as the best for every teaching situation Bassey (2015). In a single classroom therefore, the teacher can employ more than one method to facilitate learning base on his/her personal experience in the field of teaching. Studies have shown that appropriate instructional materials couple with the right choice of method facilitate learning achievement to a large extent. Ndirangu (2012). It is a necessity that a skillful teacher needs to be conversant with various teaching strategies which may be applied to subjects at different class situations. Adulfe (2008) affirms that many method of teaching exist in education and these methods are meant to make teachers succeed in their bid to impart knowledge. Also, the impact of any teaching method is not only limited to the conditions surrounding the teaching but also the advantages and disadvantages of a particular method in a particular situation should not be left out. According to (Ckenzi et al 2010) and Adesanya (2016) argues that the objectives of the lesson should be considered before the selection of any method Teaching involves bringing desirable changes in the learners and it equally requires the educator to step in to the world of the learners which will depend on the teaching methods use by the teacher in engaging the learners.

STEM is an issue that is often discussed in today's 21st century learning. Inadequate education in mathematics and science has resulted in a shortage of qualified workforce, causing inequality in the global industrial sector (Coone y & Bottoms, 2003). According (Yildirim, 2018) also suggests that improving the quality of education in the 21st century with the application of STEM has a positive effect on increasing students' critical thinking skills. Furthermore, the application of STEM with project based learning (PjBL) will support each other in implementing the learning process. PjBL learning with a STEM approach integrates STEM fields and can improve the scientific work abilities of students (Susanti, 2020; Sugiarto, 2020; Wijayanti, 2018).

Research has also shown that teaching STEM education at the elementary level using appropriate teaching strategies and techniques could benefit children in multiple domains (Tallar, 2022). On the cognitive domain, early STEM education enables children to develop

various kinds of STEM-related knowledge and nurture STEM-related thinking, improve their understanding of abstract scientific concepts, life experiences and expand their ideas on new experiences during the learning process as well as develop their agency of learning scientific knowledge.

On the affective domain, children gain opportunities to enhance STEM-related learning and are motivated to collaborate, increase participation in active learning and enhancement of their engagement in exploring activities and learning and this increases in them STEM dispositions and feelings. On the skills acquisition domain, early STEM education can also support children in developing their problem-solving skills, collaborative and creative skills, imagination, science-related questioning skills and digital skills. STEM Education has a focus on connecting learning across disciplines. It is not intended to replace learning in each of the STEM disciplines but rather recognizes that learning in each of these disciplines is not enough when done separately compared to the interdisciplinary approach.

STEM education is an interdisciplinary approach to learning which removes the traditional barriers separating the four disciplines of science, technology, engineering and mathematics. It integrates them into real-world, rigorous, relevant learning experiences for students.

Background of study

The background of this study will be examined from the historical, theoretical, contextual and conceptual perspectives.

Historical background

STEM education is broadly defined as an interdisciplinary and applied approach for teaching science, technology, engineering, and math (Hom, 2014). This approach fsocuses on teaching these four subject areas in a "cohesive learning paradigm based on real-world applications" (Hom, 2014). This is in an endeavor to meet the challenges of the 21st century and the STEM curricula incorporates hands on learning, collaboration, and creativity in the classroom which are vital 21st century skills. The STEM education program can be classified among the innovative methods of education primarily applied in teaching natural science and technical subjects at primary and secondary schools. The STEM acronym represents four scientific disciplines: S - science, T - technology, E - engineering, and M - mathematics.

STEM is an educational approach that prepares primary and secondary students for college, graduate study, and careers in science (Lutkevich, 2022).It allows students to look at real world

problems and come together to solve them in creative ways. This type of learning presents students with the opportunity to think critically outside of the box, it allows learners imagination run wild, and build in them the skills to become 21st century learners. The first wave of science, technology, engineering, and math began in 1957 when the Russian satellite Sputnik was successfully launched into space (Marick, 2016). This was the first satellite to orbit the Earth.

The United States leaders, citizens, and scientific community were astonished by this massive technological achievement. They were caught off guard and came together as a nation in an effort to catch up with the Soviets. This marks the beginning of what is now known as the "space Race" (Marick, 2016). 1970s and 1980s, technological advancements continued to move forward

The 1980s lead to the creation of the first cell phone, awed the American people and lead to the continued push for more technology. During this time, companies began to realize the untapped potential of electronic devices in the American marketplace. Companies began competing with each other by working to hone in and improve upon these technological successes. The beginning of STEM education, and the acronym it is known by, began in the early 1990s. STEM was originally referred to as science Mathematics, Engineering, Technology (SMET), before it was changed for sounding too similar to the word "smut" (Sanders, 2009). At this point in time, STEM education was not a commonly known term. When asked, many people believed that STEM was related to stem cell research and not the collaborative teaching of science, technology, engineering, and math.

In 2005 Virginia Tech launched the first STEM education graduate program (Sanders, 2009). When Virginia Tech first began referring to STEM education, they did not always implement all four areas of science, technology, engineering, and math but instead used the term when utilizing two of more of these subject areas in a collaborative way. Virginia Tech created a pedagogy they refer to as Purposeful Design and Inquiry (PD&I). "PD&I pedagogy which purposefully combines technological design with scientific inquiry, 10 engaging students or teams of students in scientific inquiry situated in the context of technological problem-solving—a robust learning environment" (Sanders, 2009).

This began the integration of utilizing all four areas of science, technology, engineering, and math in a collaborative way. The combination of these fields allowed for a deeper understanding and connection. This problem-based learning purposefully situates scientific inquiry and the

application of mathematics in the context of technological designing/problem solving which allows for authentic inquiry embedded into the design challenges (Sanders, 2009).

The next wave of STEM education began in 2009 with the Obama Administration's initiative Educate and to Innovate (Sakar, 2018). This initiative was created with the goal to increase STEM literacy, increase teaching quality, and expand educational and career opportunities for America's youth in the science, technology, engineering, and math fields (Burke, & McNeill, 2011). Obama's administration invested $3.1 billion in federal programs promoting STEM education (Hom, 2014). This money was given to fund STEM focused high schools, invest in advanced research projects, recruit and support STEM teachers, and to better understand the next-generation standards (Hom, 2014).

The initiative addressed the lack of teacher training in STEM, but opted for hiring new STEM professionals instead of training current teachers. They created this initiative with the overarching goal to move American high school students from the middle of the road to the head of the pack internationally (Hom., 2014). When this plan was initiated American students ranked 22nd among their peers throughout the world in science and 31st in math (Burke, & McNeill, 2011). In April of 2013, the Next Generation Science Standards (NGSS) were created by a team of experts and stakeholders in science and engineering in an open collaborative state lead process (Achieve, 2014,) STEM education encompasses the content, skills, and ways of thinking of each discipline and an understanding of the relationships between disciplines and how they support and complement each other (Pollard et al., 2018). (Bellová 2021, p. 12) states,' in many developed countries, interdisciplinary education in natural science subjects is preferred.'

Teaching methods have been evolving since the 19th century to suit different demands of the education community and to equally meet the demands of the global world. This evolution has mainly been a drastic shift from teacher centered approaches which is commonly referred to as the traditional approach whereby the teacher is at the centered of the teaching learning process, considered to be all knowing to transmit knowledge to learners who are considered as empty vessels to a learner centered approach whereby the learner takes ownership of their own learning, collaborate with peers and teachers, they are encourage to ask questions and proposed solutions to existing problems with the teacher acting as a guide or facilitator. In the 21st century STEM education is at the center of attraction to all educational stakeholders through which 21st century skills such as critical thinking, collaboration, creativity ,problem solving and

communication can be develop in the learners if appropriate teaching methods are use. (Sanders, 2009).

Teaching methods have undergone numerous phases of evolution in line with global trends and objectives, according to Raiser (2001), in the early century teachers where the primary means through which instruction was presented to learner. Also, in the past where many parents were interested to see their children grow in knowledge using different methods without using textbooks which will help improve their performance. During that time, teachers were untrained unlike today that teachers are train but performance is low and students are less active in class. This has led to the evolution of many methods like explicit teaching, drill and practice and dramatization which has greatly influenced learners' performance.

The most basic and earliest form of teaching method is explanation. It is the foundation of the monological teaching methods where the information is transferred from teacher to students where the learners passively receive information. The capacity to explain is one of the essential process of teaching. Therefore, to achieve the goal of teaching the teacher must adopt effective methods. The main purpose of evolution is to enable the learner to take diligent interest in the lesson and grasp the purpose of what is being taught. Explanation integrates other method of teaching like discussions, demonstration and laboratory sessions. (Havita ,2000). The evolution of teaching methods dates back from the ancient times wherein learning is very much different from what we are accustomed to today but some concepts and philosophies are still being used today. This Philosophy in ancient Greece led to questions of educational approach entering national discourse. In his work the republic, Plato described a system of instruction that he felt would lead to an ideal state. In his dialogue, Plato described the Socratic Method a form of inquiry and debate intended to stimulate critical thinking and illuminate ideas. It has been the intent of many educators to find specific interesting ways to encourage students to use their intelligence and to help them to learn. (Sanders, 2009).

In the 20th century, newer methods of teaching are evolving which are far drifting from the old methods of teacher centered approaches to learner centered approaches like discussion, cooperative learning, inquiry learning and project-based learning which are based on hands on activities that stimulate critical and creative thinking as well as reflection. Also, teaching methods in this phase has evolved to the use of educational technologies like computers, projectors, phones to facilitate learning as well as the use of other didactic material according to (Shaikh. ,1900).

Education is the process facilitating learning, knowledge, values, beliefs and skills assumed to a group of people which are transfer to other people through storytelling, discussion, teaching and training or through research. According to (Hunter.,1984), Reinhartz (1980), teaching is a professional decision that affect the probability of learning decisions that are made and implemented before, during and after interactions with the students explaining, defining and giving examples stressing critical attributes and demonstration. Successful teaching and learning emanates to a large extent from careful planning, preparation and the methods used in giving out the materials. The quality of education that teacher provides is dependent upon what the teachers do in the classroom (Effandi & Iksan 2007).

A successful learning is generally a product of effective and efficient teaching process (Vin, 2012). Before this can be done, the teacher must be fully aware of the subject matter and various methods of teaching (Okpala, 1980). Teaching methods are those techniques and strategies used by the teachers to facilitate students learning. It can equally be define as a practical application of teaching principles based on the nature of the learner, the nature of the subject and the learning need of the students.

According to Oyekan (2014), teaching methodology is concerned with what methods or techniques or approach individuals or group of teachers select and use in the actual classroom situation. It an activity that translates curriculum goals and objectives in to experience that students acquire during interaction with their teacher. Therefore, the ability of the teacher to use appropriate teaching methods will go a long way to improve students' performance. According to Tambo (2003), teaching methods are important components of the curriculum as they help to determine learning outcome. Teaching involves bringing desirable changes in the learners. However effective teaching requires the teacher to out of the realm of personal experience and step in to the world of the leaners who must be engaged for learning to occur. A skillful and competent teacher uses as many methods and techniques as possible because there is no single method which is regarded as the best for every teaching situation Bassey (2015). Studies have shown that appropriate instructional materials coupled with right choice of methods facilitate learning achievement to a large extent Ndirangu (2012**)**. It is a necessity that a skillful teacher needs to be conversant with various teaching strategies which may be applied to subjects at different class situations. Adulfe (2008) affirms that many methods of teaching exist in education and these methods are meant to make teachers succeed in their bid to imply knowledge.it is well known that no good teacher uses just one method of teaching Shield (2002) pointed out that good teacher follow no one method instead he/she uses whatever

methods and materials that seem best for the particular combination of individual situations. Also, the impact of any teaching method is not only limited to the conditions surrounding the teaching but also the advantages and disadvantages of a particular method in a particular situation should not be left out. According to Ckenzie et al (2010) and Adesanya (2016) argues that the objectives of the teacher should also be considered before the selection of any method. This implies that what the teacher intents to achieve should be in line with the selected method. Teaching methods are broadly classified in to two; learner-centered approach and student-centered approach. In the teacher centered approach, teachers are the main authority figure in this approach, student are viewed as empty vessels whose primary objectives is to passively receive information via lecture and direct instruction with an end goal of testing and assessment. Testing is based on mastery of content. In the learner centered approach to learning, while teachers are an authority figure in this approach, the learners play an active role in the learning process Mares &Krivohlavy (1995). The teacher's role is to coach and facilitate students' learning and overall comprehension of material. Students' learning is measured through both formal and informal forms of assessment including; group projects, student portfolios and class participation. Teaching and assessment is continuous and is continually measured during teacher instruction. Teaching methods that are learner centered include; discussion (debates, panels and buzz sessions), laboratory experiments, demonstrations and cooperative learning.
Education in Cameroon is very important and, in every country, as it contributes to social, political and economic development in every community. More so, education is the basic human right and it is a basic instruction for achieving the goal of national unity, political stability, equality and mobilizing all the potentials of a nation. In Cameroon, before the use of formal education they have been the existence of indigenous education around 1884 before German annexation. According to Tambo (2003) under educational administration, there existed indigenous education which governed the life of the indigenous community. The indigenous society used formal methods to transmit knowledge from the elder to the children. Before the coming of formal education from the western world the methods used were communalism. The Cameroon educational system is divided in to two, the English subsystem or the Anglo-Saxon system and the French subsystem as a result of the two colonial powers Britain and France that governed.

Education is a major contributor to the development of human capital and an innovative based economy. Thus, in order to prepare young people with the skills needed to compete in the job market and economic development, STEM education (Science, Technology, Engineering &

Mathematics) a new educational innovation was introduced in the Cameroonian Education Development Plan (GESP) 2009 blueprint. Thus, the role of teacher as an implementer of innovation should be taken seriously in promoting STEM education.

STEM education has been implemented in developed countries such as the United States, United Kingdom, Korea and Singapore. However, STEM education in Cameroon is a new innovation which is an important issue in the development of education, especially in science education. Therefore, the implementation of STEM education requires the integration that is it should not only should be implemented at the university level but should be implemented beginning from primary and secondary schools. Therefore, STEM education should be introduced earlier, while in primary schools in order to build the perception and knowledge of STEM education at the basic level (Nadelson, Callahan, Pyke, Hay, Dance, and fiester (2013) till the higher level of education in other to meet the requirements of STEM learning as a preparation for the degrees program in STEM at higher institutions (DeJarnette, 2012). .

Many researchers are convinced that STEM education contributes to learnsrs acquisition of skills such as problem solving, critical thinking, collaboration, management, self-directed learning, communication analytical thinking, creativity and innovation which will equip learners with know how needed to solve real-world problems (Asghar et al., 2013; Capraro, Capraro & Morgan, 2013; Casteldine & Chalmers, 2012; National Science Board, 2007). The aim of integrated disciplines is to demonstrate a paradigm shift from the separate subject approach to teach real-life problems (Capraro et al., 2013; Jonassen & Hung 2008) that require integrated knowledge from different disciplines and to solve the problems collaboratively in a constructivist approach (Mayer, 2004). In the past decade, there has been special interest in STEM education, especially when it is taught through effective teaching methods. (Wegerif, et al 2015). Teaching methods which align to STEM education include problem-based learning, project-based learning, hands on, minds on, inquiry based learning, blended learning and inquiry based learning.

Theoretical background

Theoretically, this study will be guided by the constructivist learning theory by Lev Vygotsky and Jean Piaget. This theory postulates that learners play an active role in the construction of knowledge and understanding of the world. It states that learners create mental models or representation of reality base on their interactions with the environment and their experiences. In other words constructivism is an approach to learning that holds that people actively

construct knowledge and that reality is based on the experiences of the learner (Elliot et al., 2000)This theory emphasizes on active learning, scaffolding whereby the child is not an empty vessel where a teacher pours knowledge but the teacher acts as a facilitator in knowledge construction with the learner(Vygotsky 1978), learning must be authentic that is occurs in real world context and it should be an interactive process (Dewey.,1938). It equally states that the environment in which children grow will influence how and what they think about (Vygotsky, 1978).

This theory is relevant in this study in that for learners to be able to acquire skills in STEM education teaching methods must be learner center foster collaboration, authentic and the teacher acting as a facilitator in the teaching learning process. The fundamental approach to the use of teaching methods such as inquiry learning is based on constructivist learning theory. Constructivist learning strategies capitalize on learning through inquiry and problem solving via critical and creative thinking. According to Asselin et al (2003) student inquirers are encouraged to explore new ideas and understandings through personal discoveries and explorations as well as interactions with objects and with other people. Learning is enhanced through the inquirers opportunity to engage in real life activities, situations and with real audience. This theory views the role of a teacher as a facilitator and guide other than an all-knowing individual who transmit facts and learners passively receive as tabular rasa.

Conceptual background

Project based learning

Project base method is a learner centered instructional method in which students learn through solving ill-structured problems (Barrows, 2000; Hmelo-Silver, 2004; Torp & Sage, 2002). Students work in collaborative groups to identify what they need to learn in order to solve a problem. They engage in self-directed learning and then apply their new knowledge to the problem and reflect on what they learned and the effectiveness of the strategies employed. The teacher acts to facilitate the learning process rather than to provide knowledge. According to (Coco, 2006) project base learning is a student-centered form of instruction which is based on three constructivist principle: learning in a specific context, active involvement of learners to achieve their goals through social interactions in the sharing of knowledge and understanding. The definition of (Coco, 2006) would be used for this study because it comprises of stem skills which are variables to be tested in this study in relation to the application of this teaching method.

Inquiry based learning

According to (Lee et al 2004) inquiry-based learning as an array of classroom practices that promote student learning through guided and increasingly independent investigation of complex questions and problems often for which there's no single answer. Students are supported to develop their abilities, ask good questions, determine what needs to be learn, resources require in order to answer those questions and share learning with others.

Inquiry-based instruction allows students to construct their knowledge from experiences that are meaningful to them, providing them with the chance to take responsibility for their learning with 60 the guidance of their teachers (Boyd, 2016). This approach fosters 21st-century skills, such as innovation and problem-solving that are crucial to prepare students for college and career readiness (Barell, 2012).

According to (Brunner, 1990) it is a constructivist theoretical basis which proposes that students construct their own meaning of reality that is it is the learners who create knowledge not knowledge being imposed on them or transmitted by direct instruction. In this study the definition of (boyd, 2016) and (barell, 2012) would be used as they fit within the context of skill acquisition in STEM education and these definitions were equally use in a similar study conducted by Tallar (2020)

Problem based learning

A popular learning strategy to increase student engagement commonly seen in inclusive STEM schools is to focus on investigating, explaining, and solving authentic, real world problems (LaForce et al., 2017). Problem-based learning is a student-centered pedagogical approach that combines the inquiry approach and problem-solving process (Etherington, 2011). The problems have a different variety of practices in problem-based learning; ill-structured problems or complex scenarios that can be adapted to students' cognitive development (Du, de Graaf, & Kolmos, 2009; Ravitz, 2009; Jonassen & Hung, 2008). Learning with PBL occurs when students go through three steps: What do they know? What do they need to know? And how can they find out what they need to know?

The definition adopted in this study is the definition of LaForce et al (2017) because it applies in the context of STEM education.

STEM Education

STEM education is broadly defined as an interdisciplinary and applied approach for teaching science, technology, engineering, and math (Hom. 2014). This approach focuses on teaching these four subject areas in a "cohesive learning paradigm based on real-world applications" (Hom., 2014). STEM curricula incorporates hands on learning, collaboration, and creativity in the classroom. It allows students to look at real world problems and come together to solve them in creative ways. This type of learning presents students with the opportunity to think outside of the box, let their imagination run wild, and build the skills to become 21st century learners

Contextual background

Besides these international conventions, the Constitution of the Republic of Cameroon guarantees the right of the child to education and further highlights it in the 1998 Law to Lay down Guidelines for Education. Section 25 which states that the education provided in schools shall take into account scientific and technological advancement and shall be tailored in terms of content and method, to national and international economic, scientific, technological, social and cultural trends, it is therefore necessary to place emphasis on STEM education in view of the current scientific and technological trends.

Also, in view of becoming an emergent nation according to the SN30 agenda the government developed the Growth and Employment Strategy Paper in 2009 to provide major orientations to all sectors of the society. The document tasked ministries in charge of education to develop the human capital required to attain this vision. The 2013-2020 Education and Training Sector Strategy Paper (ETSSP) clearly defines the missions of each sub-sector in the educational system. The Cameroon curriculum for basic education has been designed to guide the development of knowledge, skills and attitudes in the learners and to set the foundation for learning with emphasis on Science, Technology, Engineering and Mathematics (STEM) so as to meet up with the objective of the 1998 orientation law of education which states that citizens should be deeply rooted in their culture but open to the world. STEM education is a center of focus for all advance industrialize countries like the united states of America, china, Britain, France just to name a few, thus the introduction of STEM education in the Cameroon basic education curriculum is to ensure that learners upon completion of studies will demonstrate relevant skills and competencies that will not just boast the country's economy but prepare them

for global opportunities and competition. The curriculum therefore responds to one of the key missions assigned to the Ministry of Basic Education (MINEDUB).

Also, in line with the sustainable development goals specifically goal 4, which seeks to achieve quality education: ensure inclusive and equitable and quality education and promote lifelong learning for all for all and 4.4 which seeks to Equip by 2030 increase the number of youths/learners with relevant skills including technical and vocational skills for employment decent jobs and entrepreneurship theres need to verify the influence of teaching methods to achieve this STEM skills. Also, SDG9 capitalizes on industry, innovation and infrastructure. To achieve these global goals by 2030 worldwide and specifically in Cameroon it is therefore to equip learners with appropriate skills to achieve them thus STEM education. (Transforming our world: the 2030 agenda for sustainable development).

Also STEM education in the Cameroon education system is gradually taking a faster pace as government is putting more effort to ensure that Cameroon becomes a STEM economy by 2035 supplying itself with the human resources needed to excel in STEM related activities such as the creation of the department of teaching science, technology, engineering and mathematics in the university of Bamenda to train teachers with the skills, knowledge and attitude to successfully implement STEM education in the classroom setting both at the undergraduate and post graduate level at the end of which learners are awarded a degree certificate in the teaching of STEM education, but however the application of knowledge acquired by graduates still remains a big problem as most schools are either unaware of STEM education or it is being done in an insignificant way without considering appropriate teaching methods for the teaching of STEM education such as project based learning, inquiry based learning and problem Based learning as recommended by STEM education scholars and equally in adequate teacher training for the current implementers of STEM education in the field and no possibility for the absorption of graduates with adequate skills thus STEM education is still apply on paper.

Also, the emphasis on STEM Cameroon basic education curriculum (pg 14) is very essential as it facilitates the development of 21st century skills such as creativity, problem solving, critical thinking, communication, collaboration and digital literacy through which citizens can become entrepreneurial without depending on the government for jobs but they themselves become job creators through their creative and critical thinking skills acquired through STEM education thereby reducing the rate of unemployment plaguing the country. Also one of the core skills highlighted by the ministry of basic education is to equip learners to use of basic notions in Mathematics, Science and Technology Introducing notions of Mathematics, Science, and

Technology involves the acquisition of knowledge, skills and attitudes in these subject areas and the ability to use them to address challenges in real life situations and Demonstration of the Spirit of Autonomy, a Sense of Initiative, Creativity, and Entrepreneurship Developing this competence in the learner calls for the assembling of multidisciplinary knowledge and skills in view of developing the learners' social integration skills, creativity as well as managerial and entrepreneurial potentials. This emphasizes the importance of this research to attain the development of this core skills.

Previous studies explain some reasons why teachers are less prepared towards integration teaching. First, teachers lack of understanding on how to implement the integration of STEM education due to lack of content knowledge in every discipline of STEM (Weber, Fox, Sydney & Jana 2013); (Stohlmann, Moore & Roehrig (2012). Wang, 2011). Secondly, the lack of resources, support and pressure from the higher authorities (Weber et al., 2013; Stohlmann et al., 2012; Nor Shai'rah, 2015). This statement was also supported by Yahaya et al. (2010) stated that teachers should have enough a wealth of knowledge regarding the subject matter to be taught, adequate experience, use appropriate teaching strategies and skills to deliver the content. Therefore, this study aims at exploring the effects of teaching methods on skills acquisition in STEM education.

Furthermore, for STEM education to be materialize there is need for a shift from teacher centered approaches where learners are entirely passive to learner centered approach where learners are actively involved in the construction of knowledge as propose by Lev Vygotsky in his theory of socio constructivism This is highly visible in the Cameroon as the education system has been evolving from teacher centered approaches like the objective based to learner centered pedagogies like competence based approach the new vision of evaluation and project pedagogy which are all aim at making learners highly engage in the learning process and equally favors the acquisition of necessary skill thus the emphasis on STEM education.

Statement of the problem

The ministry of basic education of Cameroon emphasizes on the teaching of STEM education in primary school as written in the Cameroon primary school curriculum. This is to facilitate the acquisition of skills relevant in the 21st century such as creativity, critical thinking, problem solving, collaboration and communication and to equally equip young Cameroonians with relevant competences to support the country's vision of emergence by the year 2030.

The quality of education is significantly influenced by the teaching methods employed in the classroom especially in the primary level where foundational skills are required. However, in some primary schools in Yaoundé VI subdivision, there's a growing concern about the effectiveness of various teaching methods in fostering skill acquisition in STEM education. the researcher has observed that learners are still in poor possession of these STEM skills relevant in the 21st century. This could be influence by the use of inappropriate teaching methods in the teaching of STEM subjects which are mathematics, environmental science, health science, and technology and engineering. The lack of interest in science among young people is also influenced by how science is taught in schools (Niculae & Niculae et al., 2011). Teachers play a crucial role in this regard. This poor acquisition is shown by the percentages of first school leaving certificate results in the past 6 years.

Table 1: F.S.L.C results of the last 5 years

year	**subject**	**percentage pass**
2018	mathematics, technology and engineering,	35.5%
2019	science and technology	40.2%
2020	science and technology, mathematics	27.8%
2021	science and technology, mathematics	50%
2022	science and technology, mathematics	46.78%
2023	Science and technology, mathematics.	40.53%

Source: inspectorate of basic education Yaoundé VI

From the table above, it's glaring that the acquisition of skills in the pupils especially in science technology, engineering and mathematics is poor. Preliminary observation indicate descriptances that maybe linked to teaching methods utilized by educators. Traditional rote learning approaches may not adequately engage learners or cater for their diverse learning needs while innovative learner centered methods might offer great potential for skill acquisition, however the effectiveness of these methods still remain unclear thus it is against this backdrop that the researcher want to verify the influence of teaching methods (project based learning, inquiry based learning, and problem based learnings) on the acquisition of skills in STEM education in some primary schools in Yaoundé VI subdivision by identifying which method is most effective for skill acquisition.

Research objectives

General research objectives

- To investigate the influence of teaching methods on the acquisition of skills in STEM education in Yaoundé VI sub-division.

Specific research objectives

- To examine the effectiveness of project base learning on acquiring skills in STEM education in some primary schools in Yaoundé VI sub-division.
- To investigate the effectiveness of inquiry base learning in acquiring skills in STEM education in some primary schools in Yaoundé VI sub-division.
- To determine the effectiveness of problem-based learning on acquiring skills in STEM education in some primary schools Yaoundé VI subdivision.

Research Questions

General research question

- What is the effect of teaching methods on skill acquisition in STEM education in some primary schools in Yaoundé VI sub-division?

Specific research questions

- What is the effect of project base learning on skill acquisition in STEM education in some primary schools in Yaoundé VI sub-division?
- What is the effect of inquiry base learning in acquiring skills in STEM education in some primary schools in Yaoundé VI subdivision?
- What is the effect of problem-based learning in acquiring skills in STEM education in some primary schools in Yaoundé VI subdivision?

Research hypothesis

General research hypothesis

H1: teaching methods have an influence on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision?

H0: teaching methods have no influence on skill acquisition in STEM education in primary schools in Yaoundé 6 subdivision?

Specific research hypothesis

H1: Project base method has an influence on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

H0: Project base learning has no effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

H1: Inquiry base learning has an effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

H0: Inquiry base learning has no effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

H1: Problem base learning has an effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

H0: problem-based learning has no effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

Scope of the study/delimitation

This study focuses on the influence of teaching methods on the acquisition of skills in skills in STEM education in some primary schools in Yaoundé VI subdivision, three teaching methods; project based method,, problem based method and inquiry based method are used for the study which is carryout in some private and public primary schools in Yaoundé VI subdivision which are chosen by random sampling.

Significance of the study

The study would help teachers, curriculum developers on best teaching methods to implement or adopt in the teaching of STEM education that will facilitate the acquisition of STEM skills in primary schools.

The output of this program will provide effective instructional strategies which are necessary to equip Cameroon with strong work STEM for force necessary technological advancements and its eventual emergence in the year 2035.

This study will enable learners to undergo meaningful learning experiences that will enable them to achieve relevant skills to meet with the demands of the 21st century as well as the global economy

This study will equally set the pace and facilitate the process towards the attainment of sustainable development by equipping 21st century learners with necessary skills indispensable for the attainment of these goals such as critical thinking, creativity, collaboration and entrepreneurship

The findings of this study may also be utilized to establish and improve teacher-development and education programs. Most prominently, programs for pre-service teachers which should emphasize having a student-centered classroom and move away from promoting a lecture-based

instructional approach. Programs should also promote active learning in the classroom and provide teachers with better resources to make learning contextualized and relevant to students. More so, teachers should be exposed to the learning strategies that revolve around a constructivist approach, such as problem base method, project based method, collaborative learning, inquiry-based learning, and cooperative learning. It is essential for programs not just to instruct teachers to utilize these approaches, but also to provide training as to how to utilize these approaches for specific subjects

The study would serve as literature to future researchers in the field of STEM education in the elementary school in particular and education as a whole. It will also create reawakening concerning STEM education thereby encouraging other researchers to work in the discipline so that it becomes very realistic and practical in the Cameroon education system

Operational definition of terms

Teaching methods: according to Tambo (2012) it is a standard procedure for presenting subject matter and organizing teacher-student interaction during a lesson.

STEM education: According to Simoncini & Lasen (2018) it is an effort to integrate some or all of the four disciplines, including science, technology, engineering and mathematics based on everyday life problems.

According to Bybeee (2010) and Erol (2021) STEM education is integrated thinking and problem solving.

Hom, E., (2014) STEM education is broadly defined as an interdisciplinary and applied approach for teaching science, technology, engineering, and mathematics.

STEM skills: according to Binkley et al (2011) Twenty first century skills are abilities and attributes that can be taught or learn in order to enhance ways of thinking, learning, working and living in the world. These skills include innovation, creativity, critical thinking, problem solving, decision making, communication, collaboration, digital literacy and personal and social responsibility. These skills include the ability to problem-solve, innovate, gather and evaluate evidence, think critically, and apply learned knowledge (U.S. Department of Education.)

CHAPTER 2
REVIEW OF RELATED LITERATURE

This chapter covers the conceptual review, theoretical review and the empirical review of literature as well as the conceptual diagram. The literature is reviewed based on the specific research objectives of the study.

Conceptual review

Teaching methods

Teaching methods refer to the general ways through which teachers teach different lessons and contents such that knowledge, skills and attitudes can be attain by learners as well long-term attainment of educational goals and aims.

According to Oyekan (2014), teaching methodology is concerned with what methods or techniques or approach individuals or group of teachers select and use in the actual classroom situation. It an activity that translates curriculum goals and objectives in to experience that students acquire during interaction with their teacher. Therefore, the ability of the teacher to use appropriate teaching methods will go a long way to improve students' performance. According to Tambo (2003), teaching methods are important components of the curriculum as they help to determine learning outcome.

Teaching strategies are the most critical aspect of pedagogy that influences the process of organizing and managing the classroom (Shulman, 1987). Active teaching practice involving student-centered approach is the most effective teaching process to integrate STEM in teaching. Teaching strategies that are associated with the integration of STEM education is project-based learning, problem-based learning and inquiry-based learning. Zimmerman (2010) stated that the project-based learning is an instructional method that allow students to develop skills and acquire knowledge through projects, cooperative learning and 'hands-on' activities. While the project or activity in STEM education involves 'hands-on' activity enhances better learning for secondary school students (Jiang, Doverspike, Julie, Paul & Menzemer (2010).Thus, project-based learning is synonymous with STEM education that involves 'hands-on' activity such as creating a product. In line with Ravitz (2010), project-based learning is often characterized by the production of a product or artefact at the end of the lesson. Though with emphasis on STEM education, STEM is still taught in Cameroon schools as individual subjects like environmental science, health science, technology and engineering, mathematics and information and communication technology (ICT).

Teaching methods are broadly classified in to two; learner-centered approach and student-centered approach. In the teacher centered approach, teachers are the main authority figure in this approach, student are viewed as empty vessels whose primary objectives is to passively receive information (via lecture and direct instruction) with an end goal of testing and assessment. Testing is based on mastery of content. In the learner centered approach to learning, while teachers are an authority figure in this approach, the learners play an active role in the learning process Mares &Krivohlavy (1995). The teacher's role is to coach and facilitate students' learning and overall comprehension of material. Students' learning is measured through both formal and informal forms of assessment including; group projects, student portfolios and class participation. Teaching and assessment is continuous and is continually measured during teacher instruction. Teaching methods that are learner centered include; discussion (debates, panels and buzz sessions), laboratory experiments, demonstrations and cooperative learning. Learner centered methods are use in this study which are project-based method, problem-based method and inquiry-based method.

Project based learning

Project based method otherwise known as project-based learning is a hands-on approach whereby learners learn by doing. Learners are given the opportunity to demonstrate their knowledge and competences by engaging in meaningful projects that address real life situations and problems. Projects carryout are centered on learners' interest and motivation and begin with the identification of problems plaguing the learners' immediate environment. It is a research-based method of learning, wherein, together with the learners, questions are asked, investigated and solutions proposed and presented.

Project-based learning is also referred to as a pragmatic approach to learning in which learners create their own knowledge through learning activities built around intellectual inquiry and a high degree of engagement with meaningful tasks. Projects are designed to allow learners with a variety of different learning styles to demonstrate their acquired knowledge, skills and attitudes. Therefore, a well-designed Project-Based Learning activity is one which addresses different learning styles and does not assume that all learners can demonstrate their knowledge, skills and attitudes in a single or standard way. It is an effective way of connecting classroom activities to the real world through a process of integrating the four broad based competences in the learner's life. (Cameroon primary school curriculum pg. 16 2018)

The above view is in line with the study of Thomas (2000:1) defines Project based learning as a model that organizes learning around projects. Projects are complex tasks, based on challenging

questions or problems that involve students in designing, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations (Diehl, Grobe, Lopez, & Cabral, 1999). Project based method is a learner centered pedagogy based on constructivist learning theory whereby learners are actively involved in the creation of knowledge working as individuals and equally in groups. In this approach to teaching and learner the role of a teacher is a facilitator who guides leaners in the construction of knowledge by giving hurdle help and creating learning environment and in some cases provide learning resources to create an atmosphere that favors the exploration of ideas, attitude And skills which will prompt the development of open ended questions identification of problems plaguing the environment and the society as a whole thereby setting the pace for project base learning.

In propagating this method, Kilpatrick defined a project as "a purposeful activity which proceeds in a social environment". (Kilpatrick, 1918). Also, according to Stevenson () who perfected it as a method of teaching said, "it is a problematic act carried to completion in its natural setting" (Stevenson, 1978) According to C.V. Good "A Project is a significant unit of activity, having educational value and aimed at one or more definite goals of understanding. It involves investigation and proposing solutions to a problems and it is frequently the use and manipulation of physical materials. It is planned and carried to completion by the pupils and the teacher in a natural life-like manner." large or small. It may be employed according to the mental age of the pupils. But that must be done under the guidance of an expert. Psychologically, the project method is based on the principles of learning by doing which encourages maximum amount of purposeful activity on the part of the pupils. Adopting this method, the heart, head and hand are to be functional. That means both the physical and also the mental powers of the child are to be exercised or utilized.

In this light, project base method can be described as a collaborative inquiry-based teaching method where students are integrating, applying and constructing their knowledge as they work together to create solutions to complex problems (Guo et al., 2020) The teacher equally group students following their different abilities, draw project schedule, distribute tasks for each group and equally supervises the evaluation of the final outcome of the project. Project based learning leads to the production or creation of a concrete product which would solve the problem identified. In the course of the project, learners are given ample time to brainstorm different solutions propose, share and discuss ideas on how to solve the problem observe, try different methods to find what really works. Also, project-based learning involves the integration of

different disciplines thus different principles and theories are applied in order to come out with a given solution to a problem.

Project-based learning organizes learning around the creation of a presentation or a product that is usually shown to an audience. This could include the creation of an original play, a video, or an aquarium design judged by local architects (Barron & Darling-Hammond, 2008, p. 40). According to Thomas (2000), PBL projects involve: complex tasks based on challenging questions or problems that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations. Responding to the question "what must a project have in order to be considered an instance of PBL?" Thomas argues that the following criteria need to be in place. He elaborates on each in his review of the literature.

Projects are focused on questions or problems that "drive" students to encounter (and struggle with) the central concepts and principles of a discipline. Projects involve students in a constructive investigation. Projects are student-driven to some significant degree. Projects are realistic, not school-like. Project based learning is also call Project-based instruction. It contextualizes learning by presenting learners with problems to solve or products to develop. Project-based instruction is a holistic instructional strategy rather than an add-on. Project-based work is an important part of the learning process. This approach is becoming even more meaningful in today's society as teachers increasingly teach groups of children who have different learning styles, cultural and ethnic backgrounds, and ability levels. The traditional approach to learning does not help all kids achieve high standards. Project-based instruction builds on children's individual strengths, and allows them to explore their interests in the framework of a defined curriculum. In project-based learning, students gain deep content knowledge and develop essential skills by responding to a complex or open-ended question or challenge for a period of time which varies in duration depending on the length of the project.

Project Based method is built upon authentic learning activities that engage student interest and motivation. Learners tend to retain more and gain more skills compared to traditional teaching methodologies like John Dewey (1978) once remark 'give learners something to do and not something to learn'. These activities are designed to answer a question or solve a problem and generally reflect the types of learning and work people do in the everyday world outside the classroom. Project base method is synonymous with learning in depth. A well-designed project provokes students to encounter (and struggle with) the central concepts and principles of a

discipline. Project base method teaches students 21st century skills as well as content. These skills include communication and presentation skills, organization and time management skills, research and inquiry skills, self-assessment and reflection skills, and group participation and leadership skills. Additionally, it has been shown to improve students' skills in critical thinking and question-posing (Sasson et al., 2018).

There is also some evidence that project base method might contribute to developing students' intra- and interpersonal skills of learners which are very essential in today's job market (Kaldi et al., 2011) project base method is generally done by groups of students working together toward a common goal. Performance is assessed on an individual basis, and takes into account the quality of the product produced, the depth of content understanding demonstrated, and the contributions made to the ongoing process of project realization. PjBL allows students to reflect upon their own ideas and opinions, exercise voice and choice, and make decisions that affect project outcomes and the learning process in general. PJBL involves hands on and minds ion which make learners more engage in the learning process thereby fostering the acquisition of knowledge skills and attitude necessary for proper integration of the learner in to the society and this learning methodology is backed by the words of the Chinese philosopher Confucius and the American statesman Benjamin Franklin which says 'tell me and I will forget show me and I may remember, involve me and I will understand'

Schwartz et al. (2004) point out that project base method is fairly common in various fields including music and languages.

Project based learning has become common and mostly use in science disciplines especially STEM education as it fosters its key principles which are collaboration, communication creativity and critical thinking project base method play a large role in the context of educational environments because the project method is seen as a way to reach education goals. In addition, it is an authentic instructional model or strategy in which students plan, implement, and evaluate projects that have real-world applications beyond the classroom (Blank, 1997; Dickinson, et al, 1998; Harwell, 1997). According to Moss & Van Duzer (1998:2) Project-based language instruction is a flexible methodology allowing multiple skills to be developed in an integrated, meaningful, ongoing activity.

Project base learning favors an interdisciplinary or integrated approach to teaching and learning as knowledge is required from different subject areas in other to completely carryout a project thus its indispensable role as a teaching strategy in STEM education.

Some basic principles of project-based learning are:

The project must be based on a-mental or motor activity.

Project may be individual or co-operative It must be purposeful in its action.

Under the project, the children must accumulate experience-manipulative, concrete or mental.

It must provide real experience. It must be useful in nature.

According to (Markula and Aksela; 2022), the key characteristics of PjBL are:

- **Driving question**: according to (Hasni et al., 2016) The driving question which sets the pace for brainstorming as project based learning as a whole must have an authentic link to the real world experiences of the learners such that at the end of the project the solution should be relevant in solving daily life problems encountered in the society. That is to say, the driving question should be authentic. The driving question is open-ended. Authenticity can also be demonstrated by having students participate in using scientific practices (Hasni et al., 2016)., "The driving question creates the need to understand the central scientific concepts related to the studied subject
- **Learning goals**: learning goals which are sometimes referred to as learning objectives learning goals stated by students and teacher. The role of the students in the statement of learning goals cannot be undermined as their participation awakens their engagement and motivation throughout the project as they feel directly involve in the teaching learning process. The teacher most often just guides learners towards the formulation of these learning goals and objectives. These goals must be SMART that is Specific, Measurable, Achievable, Realistic and Time bound. The goals must reflect the curriculum and facilitate the achievement of educational aims.
- **Scientific practices:** Project based learning is a scientific practice and as such it follows the scientific method by; Asking questions from predictions observe, formulation of hypothesis,

Collection of data and experimentation, data analysis, reflection, presentation and communication of results.

These scientific practices are necessary critically and develop creative solutions to discuss creative solutions to solve problems encountered and equally develop good communication skills in the process of reflection and communication of results, Scientific practices were studied through the phases of inquiry-based learning, as they describe the scientific practices that students carry out in practice within one research project (Pedaste et al., 2015). First phase, 'orientation', was left out as its outcome, the driving question, is studied separately. Many models developed for evaluating the quality of inquiry-based learning can be adapted for PBL

(Thys et al., 2016). Also, for example, (Mentzer et al. 2017) studied how teachers implemented the phases of inquiry-based learning in their PBL unit plans. This phase of inquiry-based learning are adapted in STEM education as it is usually considered as a type of inquiry based learning.

- **Collaboration:** in the course of the carrying out project-based learning, learners collaborate with their peers and the teacher. They share ideas with each other and brainstorm different solutions in pairs and in groups, sometimes they are group in pairs to think then share their findings with the whole group which is a pedagogic approach referred to think pair share. The teacher collaborate with learners by ensuring that they respect the timeframe and provide help when learners are faced with obstacles beyond their capacity a process known as scaffolding as postulated by Vygotsky in his theory on constructivism as the teacher is considered the more knowledgeable order. This enables the learners to collaborate and built in them the spirit of team work and cooperation.
- **Use of technological tools**: project-based learning sometimes requires the use of ICT (information and communication technologies such as telephones and laptops to do research on some principles before applying them and to equally check better ways to carry out the project. Information and communication technologies are equally use in typing and [resenting reports on projectors at the end of the project activity. This helps the learners to become digital literates which is an essential skill needed to function in the 21st century as the world is slowly becoming a global village through digitalization,
- **Creation of an artefact**: at the outcome of the project activity specifically in stem education should be a tangible artifact which answers the driving question and solves the problem highlighted (Krajcik & Shin 2014) outline that the artefact should answer the driving question, reveal the students' level of understanding and support students in gaining an understanding about the topic. The realization of the artefact makes project-based learning fulfilling and encourages learners to engage in more meaningful projects.

According to the Cameroon primary school curriculum (2018 pg. 16) project-based method should be implemented in the following ways Identify a problem: This has to be done together with the learners in order to give them ownership of their learning and the final product which is the project. Once a problem is identified, a project is designed to bring about a solution to the said problem.

It starts by identifying all the parts of a project namely: Beginning, progression and a culminating event. That is, you should master how to start off with the project because as mentioned earlier, it should be a process that involves learning across the curriculum or better still, across all subjects. There is a progression part in a project in Project-Based Learning in order to show that the project is not an end in itself but a means to an end. This implies that the subjects are taught in order to enable the learner either solve a problem or produce something concrete.

Brainstorm with colleagues about the progression and set aside a "Project Book" where ideas are jotted down. Points about the progress of the project should equally be jotted (monitoring progress). This enables the actors in the project to see what is working and what is not working and reformulate questions and bring out more concrete solutions. This will also lead or aid in the culmination event where the entire process will be explained.

- **Discuss with learners**. Learners are skilfully guided both in class and at the project site towards the realization of the project. The learner's place should not be taken up by the teacher; they should be guided to complete or carry out tasks as individuals and as groups as the case may be. The tasks should not be carried out for them: leading questions and clues are vital in helping them carry out their tasks. Assign a role to every learner. No learner should feel isolated or abandoned nor left behind. Assigning roles empowers them and builds the spirit of togetherness, initiative, creativity and responsibility in the learner

Discuss the progress of the project with individual learners, groups and with the whole class. Discussing the progress of the project entails participation, improving on aspects that are lacking and making the project participants (learners) feel anxious to complete the task/solve the problem. Respect all the three parts of the project, that is, introduction (identifying a problem and proposing a solution, that is, a project), progression (carrying out the project) and the culmination event (presenting and evaluating the project).

More important, evidence shows that PBL enhances the quality of learning and leads to higher-level cognitive development through students' engagement with complex,

According to Railsback (2002:9) Project based method appears to be an equivalent or slightly better model for producing gains in academic achievement, although results vary with the quality of the project and the level of student engagement. It is also clear that PjBL equips learners with the ability to understand complex processes and procedures such as planning and communicating. Reports from researchers prove that project based method is a rigorous,

relevant, and engaging instructional model that supports authentic inquiry and autonomous learning for students. Followings are some benefits of project-based learning (Railsback, 2002:9-10).

- **Cooperation and teamwork**: Students have the opportunity to apply what they have learn in the contemporary society. Participation usually occurs in groups and students learn skills such communication and cooperation. Leadership and interpersonal skills are equally develop in group work thus equipping learners with 21st century skills which are vital in the job market.
- **Reflection and communication**: In project-based learning, learners work in groups, and they learn life skills such as cooperation and communication, learners work in groups which enable them to share ideas, carry out different tasks to realize a unique outcome thus fostering collaboration, PBL emphasizes teamwork and effective collaboration between the team members working on the projects. When students work cohesively as a unit to solve a real-world problem, their interpersonal and communication skills are enhanced which is very vital in the professional circle and job market.
- **Makes learning fun:** As pupils work in groups trying to bring out solutions and trying to figure out what works best through trial and error, brainstorming sessions and focusing on practical application thus making learning fun and less stressful connects school with reality which makes learning more relevant and contextual.

Project base method enhances the decision-making skills of the students because they had to take critical decisions during the course of projects regarding the research path and tools which should be used to reach an effective outcome.

- **It is known that every individual is unique and has his/her own strengths and weaknesses**. PBL helps teachers to judge the students' abilities, strengths, and weaknesses which are often overlooked in other assessment methodologies. Problem base method leads to enhanced student engagement. When students gain knowledge practically, their natural curiosity and interest in the subject matter increases. As a result, a greater student achievement in academics which can be measured through variables such as higher attendance in the classroom, increased learners interest and improvement in grades. The Steps involve in conducting project base learning are:

Identification of a Problem or an Opportunity

This is the leading step in project-based learning. Teachers and students identify a problem or an opportunity from their surroundings that requires meticulous work and demands a solution. This problem can be related to the topic under study and the curriculum and how it may be affecting the school, community, city or a country. When the problem is sort out, learners proceed to brainstorming possible solutions and weighting them considering cost, feasibility, skills needed and possible stakeholder's involvement. The sole role of the teacher is to facilitate learning and problem discovery through guiding questions. The discovery of the problem by learners will help to arouse and sustain their interest throughout the project

Project Planning

The next step is to design a learning plan for the project which means that the teachers assess how the problem or opportunity connects with the standards he/she is intending to teach. The best approach is to involve the students in this process so that they can feel included. The facilitator must select the project path which corresponds to the syllabus or curriculum. It is better to integrate multiple subjects for enhanced student engagement and dynamic learning. Teacher must ensure that the learning resources and content are at the students' disposal while they are working on the project. A teacher should be prepared to provide deep content knowledge to the students because the project can move in any direction and students may require a deeper understanding of the concepts to reach a viable conclusion. Also, the role of the teacher at this phase is to create groups, provides the materials needed for the project, assign group leaders and orientate learners about each phase of the project.

Schedule: This is the third step of the PBL which involves setting a timeline and schedule for the project activities. Learners should be given a set date or time frame in which they have to present their final project work. However, to realize the benefits of the whole process, be prepared to be flexible in your schedule. Set the schedule by working collaboratively with students. Rubrics allow teachers to grade student learning against certain standards and give effective feedback to the individual student at the end of the project. The assessment helps students in enhancing their skills and thus increases their confidence. Besides teachers, experts and the audience can also be consulted to give feedback.

Monitor the Progress: In project base method, a teacher is engaged in the process right from the beginning to the end. Teachers should incessantly monitor student work and progress. The role of the teacher in PBL is that of a facilitator who strives to make the learning experiences worthwhile for the students. Monitoring is also essential to keep learners focus and consistent

in carrying out the task. It equally enables the teacher to identify loopholes in the activity as well as obstacles which might be hindering learners from progressing and assist by providing help to enable the successful achievement of the project.

Assessment and evaluation: This is the fifth step of the PBL, and it involves assessing the learning outcomes and participation of students. Assessment occurs at different levels, formative assessment which is ongoing guidance provided to students during the project. It also involves the teacher to monitor learners' understanding and skill development and provide timely support. In authentic assessment, learners are evaluated on the real world tasks and assessment carry out. It involves prototypes, simulations and project pitches. Project base method cumulates with summative assessment whereby teachers can use a rubric to record students' progress and their learning outcomes. This is the last step in problem based learning which involves reflecting what worked and what didn't during the whole process. Reflection helps teachers to improve their instructional strategies in the future. Teachers are also able to incorporate changes in their teaching strategies.

Disadvantages of project base learning

Though project-based learning has numerous advantages as presented in the above paragraphs, it equally has some limitations which are shown in the subsequent paragraphs.

Time**:** Many instructors feel comfortable with traditional classroom where they own and control the learning process as they are considered all-knowing while learners are tabular rasa or empty vessels that need to be filled. (Kemdibud, 2013). This is difficult also, Both (Viro et al. 2020) and (Aksela & Haatainen 2019) found that according to STEM teachers, the most challenging aspects of implementing PBL are project organization (for example, time management), technical issues, resources, student-related challenges and collaboration

Resource availability: PBL often requires specific materials, technologies, and spaces that might not be readily available in all schools, leading to potential resource constraints. Also, most resources are costly and some scarce which makes project realization difficult and so discourages project-based learning in STEM education especially in developing countries like Cameroon.

Teacher training: Implementing high-quality PBL requires teachers to have a specific set of skills and comfort with more open-ended projects, which can be a shift from traditional teaching methods.

Student motivation: Greater autonomy and independence in learning may not resonate with all students, potentially leading to challenges in participation for those used to more structure learning styles.

Sustaining momentum: Keeping students consistently engaged and motivated throughout longer-term projects requires ongoing effort and creativity from educators which is a very challenging task.

Inquiry based learning

Inquiry-based learning is primarily a pedagogical method, developed during the discovery learning movement of the 1960s as a response to traditional forms of instruction – where people were required to memorize information from instructional materials.[1] The philosophy of inquiry based learning finds its antecedents in constructivist learning theories, such as the work of Piaget, Dewey, Vygotsky, and Freire among others, and can be considered a constructivist philosophy. Generating information and making meaning of it based on personal or societal experience is referred to as constructivism. Dewey's experiential learning pedagogy (that is, learning through experiences) comprises the learner actively participating in personal or authentic experiences to make meaning from it. Inquiry can be conducted through experiential learning because inquiry values the same concepts, which include engaging with the content/material in questioning, as well as investigating and collaborating to make meaning. Vygotsky approached constructivism as learning from an experience that is influenced by society and the facilitator. The meaning constructed from an experience can be concluded as an individual or within a group.

In the 1960s Joseph Schwab called for inquiry to be divided into four distinct levels. This was later formalized by Marshall Herron in 1971, who developed the Herron Scale to evaluate the amount of inquiry within a particular lab exercise. Since then, there have been a number of revisions proposed and inquiry can take various forms. There is a spectrum of inquiry-based teaching methods available.

John Dewey, a well-known philosopher of education at the beginning of the later century, was the first to criticize the fact that science education was not taught in a way to develop young scientific thinkers. Dewey proposed that science should be taught as a process and way of thinking – not as a subject with facts to be memorized. While Dewey was the first to draw attention to this issue, much of the reform within science education followed the lifelong work and efforts (Schwab.2000). Science did not need to be a process for identifying stable truths about the world that we live in, but rather science could be a flexible and multi-directional inquiry driven process of thinking and learning. Schwab believed that science in the classroom should more closely reflect the work of practicing scientists. Schwab developed three levels of

open inquiry that align with the breakdown of inquiry processes that are done today (schwab., 2000)

Students are provided with questions, methods and materials and are challenged to discover relationships between variables, Students are provided with a question but however the method for research is up to the students to develop. Also in inquiry base method phenomena are proposed but students must develop their own questions and method for research to discover relationships among variables .Inquiry learning involves developing questions, making observations, doing research to find out what information is already recorded, developing methods for experiments, developing instruments for data collection, collecting, analyzing, and interpreting data, outlining possible explanations and creating predictions for future study.[

Inquiry-based method is used here as a broad umbrella term to describe approaches to learning that are driven by a process of enquiry. It is entirely a learner centered pedagogy and learners are active other than passive in the teaching learning process. The tutor establishes the task and supports or facilitates the process, but the students pursue their own lines of enquiry, draw on their existing knowledge and identify the consequent learning needs. They seek evidence to support their ideas and take responsibility for analyzing and presenting this appropriately, either as part of a group or as an individual supported by others. They are thus engaged as partners in the learning process. Inquiry based learners involve learners asking open ended questions which may be guided by the teacher or they do it independently that is open ended inquiry. The questioning phase helps to ignite the curiosity of learners help think critically and collaboratively so as to bring out the solution to the problem face. Inquiry based learning is focus on the process of learning and not the product.

According to Barrow (2006) the National Research council (1996, 2000) defined scientific inquiry as a process where students:

Identify questions and concepts that guide investigations (students formulate a testable hypothesis and an appropriate design to be used);design and conduct scientific investigations (using major concepts, proper equipment, safety precautions, use of technologies, etc., where students must use evidence, apply logic, and construct an argument for their proposed explanations),use appropriate technologies and mathematics to improve investigations and communications; Formulate and revise scientific explanations and models using logic and evidence (the students' inquiry should result in an explanation or a model), recognize and

analyze alternative explanations and models (reviewing current scientific understanding and evidence to determine which explanation of the model is best).

Communicate and defend a scientific argument (students should refine their skills by presenting written and oral presentations that involve responding appropriately to critical comments from peers). Accomplishing these six abilities requires K–12 teachers of science to provide multi-investigation opportunities for students. (Barrow, 2006, p. 268) According to Barrow (2006) "when students practice inquiry, it helps them develop their critical thinking abilities and scientific reasoning, while developing a deeper understanding of science" (p. 269). The National Research Council (2000) supports the findings of Barrow

Specific characteristics of inquiry-based learning are

Creating questions of their own.

Obtaining supporting evidence to answer the question(s).

Explaining the evidence collected.

Connecting the explanation to the knowledge obtained from the investigative process.

Creating an argument and justification for the explanation.

There are four levels of inquiry-based learning according to (Mulholland. 2019)

- **The structured inquiry approach:** this type of inquiry is a sequential process whereby learners learn to ask questions and investigate real world problems following the scientific method or any other structured method so as to generate an evidence.
- **Guided inquiry:** in this type of inquiry the teacher who is the facilitator of the teaching learning process provides an open question for learners to ponder so as to ignite their curiosity, develop their critical thinking capacity and problem-solving abilities using a teacher given method or their own design method.
- **Open inquiry:** this type of inquiry is such that learners are given the time and support to develop their own questions, develop their own investigation method and verify its credibility at the end of which they present their findings for further discussion and expansion. This method is aim at building independence in the learners as well as a sense of collaboration and cooperation amongst their peers.
- **Confirmatory inquiry:** in this type of inquiry learners are given a question and its answer beforehand. They are then given a specific procedure by the facilitator to verify the answer. This type of inquiry is aim at building investigation and critical thinking skills and equally to demonstrate how a specific method works.

The above levels are used interchangeably in the classroom base on the appropriate skills the teacher seeks to cultivate in the learners but open inquiry is usually for level 3 that is class 5 and 6.

An important aspect of inquiry-based learning (and science) is the use of open learning, as evidence suggests that only utilizing lower level inquiry is not enough to develop critical and scientific thinking to the full potentials Open learning has no prescribed target or result that people have to achieve. There is an emphasis on the individual manipulating information and creating meaning from a set of given materials or circumstances. In many conventional and structured learning environments, people are told what the outcome is expected to be, and then they are simply expected to 'confirm' or show evidence that this is the case.

Open learning has many benefits. It means students do not simply perform experiments in a routine like fashion, but actually think about the results they collect and what they mean. With traditional non-open lessons there is a tendency for students to say that the experiment 'went wrong' when they collect results contrary to what they are told to expect. In open learning there are no wrong results, and students have to evaluate the strengths and weaknesses of the results they collect themselves and decide their value.

Also, Banchi and Bell (2008) explained that teachers should begin their inquiry instruction at the lower levels and work their way to open inquiry in order to effectively develop students' inquiry skills. Open inquiry activities are only successful if students are motivated by intrinsic interests and if they are equipped with the skills to conduct their own research study.

The America's National Science Education Standards (NSES) (1996) outlines six important aspects pivotal to inquiry learning in science education.

Students should be able to recognize that science is more than memorizing and knowing facts.
Students should have the opportunity to develop new knowledge that builds on their prior knowledge and scientific ideas.
Students will develop new knowledge by restructuring their previous understandings of scientific concepts and adding new information learned.
Learning is influenced by students' social environment whereby they have an opportunity to learn from each other
Students will take control of their learning.

The extent to which students are able to learn with deep understanding will influence how transferable their new knowledge is to real life contexts.

Phases of inquiry-based learning

The phases of inquiry-based learning vary according to authors though the contents are the same most often it is just the name that changes. The phase use in this study are those propose by (Margus et al; 2015) which are:

- **Orientation Phase;** this phase is equally referred to as triggering, observation and exploration phase, the topic. Students or the inquirers see the whole project as a puzzle that needs to be solved. The point of interest might be a real-life scenario, a topic posted by the teacher or a pertinent problem that captures students' attention and motivates them to ask questions and explore further. The stages of this phase are summaries in these points; Figuring out or exploring the general questions that need to be investigated. Verification of information and finding of materials regarding the particular topic from different sources, determining the way to present the information to the target audience and suggesting the criteria pertinent to their research product and process evaluation. (Jonassen, 2000).
- **Conceptualization phase**: this phase of inquiry involves the exploration of concepts related to the problem under investigation. It equally involves sub phases such as questioning and hypothesis formation.so as to make the work verifiable and objective. The questions ask are usually open-ended questions that stimulate critical thinking and creativity skills in the course of presuming what works based on hypothesis. Instructors may also encourage cooperative and collaborative activities among the learners whereby they can be teamed up in their creative efforts and come up with the relevant resources, discussions and on-line projects (Mc Gregor, 2003).
- **Investigation phase:** at this phase, learners following a specific procedure to verify their hypothesis usually employing the scientific method. This phase comprises of experimentation, data collection, analysis and interpretation. It equally involves gathering different pieces of information so as to answer the driving question.
- **The conclusion phase**: this phase marks the end of learners' investigation. The learners answer the driving question or test the solution to the problem. This phase can lead to further inquiry. In this phase learners address their original research questions or hypotheses and consider whether these are answered or supported by the results of the study (Scanlon et al., 2011; White, Shimoda, & Frederiksen, 1999). It may lead to new

theoretical insights. The outcome of the Conclusion phase is a final conclusion about the findings of inquiry-based learning, responding to the research questions or hypothesis. It equally provides an opportunity for feedback and knowledge exchange.

- **The discussion phase**: this phase gives an opportunity for learners to communicate and reflect. Communication can be seen as an external process where students present and communicate their findings and conclusions to others, and receive feedback and comments from others (see Scanlon et al., 2011) and sometimes listen to others and articulate one's own understandings (Bruce & Casey, 2012). Reflection is defined as the process of reflecting on anything in the learner's mind, e.g., on the success of the inquiry process or cycle while proposing new problems for a new inquiry cycle and suggesting how the inquiry-based learning process could be improved (Lim, 2004; White & Frederiksen, 1998). It is mainly viewed as an internal process (What did I do? Why did I do so? Did I do well? What are the other options in a similar situation?). Within this process, several activities, such as role-play, writing a diary or narrative, and guiding questions, can be distinguished as support for this (Runnel, Pedaste, & Leijen, 2013), and these can help students' reflections to reach specific levels of quality: description, justification, criticism and discussion (Leijen et al., 2012). Thus, reflection is often more focused on the inquiry-based learning process and communication on domain-related outcomes of this process.

Advantages of Inquiry based learning

Active Engagement: inquiry-based learning encourages active learning and participation.by exploring questions and seeking answers, learners become actively involved in the learning process. This active engagement enhances their understanding and retention of the material.
Critical thinking skills: inquiry base learning promotes the development of critical thinking skills when learners are involve in formulating questions, investigating information sources and analyzing evidence, they are encourage to think critically and evaluate information for its credibility, relevance and reliability.
Autonomy and self-direction: inquiry base learning encourages and empowers learners to take ownership of their learning. They set goals, identify learning needs and seek out relevant resources. This fosters autonomy, self-direction and a sense of responsibility for their learning journey. Learners are allowed to make decisions on how they want to go about the project as well as the resources and how they want it organize. This helps to equip them with the ability to carry out their day to day tasks independently as well as lifelong learning abilities. It will

equally boast logical thinking in the learners as pertaining each decision they make and the responsibility of the consequences.

Collaboration and communication: this teaching method involves collaboration with peers and experts. Learners engage in discussions, share ideas and collaborate on projects. Learners work collaboratively to share ideas, delegate responsibilities and coordinate their efforts. This fosters the development of team work, communication and interpersonal skills which are vital for proper integration in the 21st century in professional and social context. Also, learners practice effective communication skills such as listening, speaking, writing, constructive feedback and negotiation. This vital as it opens learners to excellent opportunities in the global economy.

Problem solving abilities: inquiry-based learning involves solving complex problems and answering open ended questions. Through this process, learners develop problem solving abilities such as identifying patterns, formulating hypotheses, testing ideas and drawing conclusions which are applicable to real world scenarios.

Information literacy skills: inquiry-based learning requires learners to locate, evaluate and effectively use information from various sources .it helps to develop their information literacy skills such as their ability to find and access reliable sources, synthesize information and properly site references. These skills are valuable in the digital age where information is abundant but with questionable reliability.

Social interaction. This helps attention span and develops reasoning skills. Social interaction encourages students to generate their own ideas and critique in group discussions. It develops agency, ownership and engagement with student learning.

Exploration. This allows students to investigate, design, imagine and explore, therefore developing curiosity, resilience and optimism.

Argumentation and reasoning. This creates a safe and supportive environment for students to engage in discussion and debate. It promotes engagement in scientific discussion and improves learning of scientific concepts. It encourages students to generate questions, formulate positions and make decisions.

Positive attitudes to failure. The iterative and evaluative nature of many STEM problems means failure is an important part of the problem-solving process. A healthy attitude to failure encourages reflection, resilience and continual improvement.

Motivation and engagement: inquiry-based learning enhance learners' engagement and motivation with the subject matter. By allowing them to explore their own questions and interest

it taps in to their intrinsic motivation and curiosity. This can lead to a deeper level of engagement and a more positive attitude towards learning.

Encourages creativity: This concept of learning encourages creativity. When students are given the opportunity to explore a problem independently, they often come up with creative solutions. This is due to the fact that no particular way of thinking restricts them.

Disadvantages of inquiry-based learning

Assessment difficulties: Students don't know when they've been "successful" Inquiry-based learning doesn't typically rely on traditional assessment methods. Preparing tasks and activities with highly structured assessment models don't always work well in inquiry learning. For many students, the lack of a rigid assessment structure is confusing and can create unnecessary anxiety. This is a common problem with inquiry because some students are not prepared for the flexibility and freedom associated with this kind of learning. They have a hard time determining if they are on the right path or if they're "doing it right". Providing structure and support is crucial with inquiry learning.

Students have difficulties with collaboration and teamwork: there is a shift from a focus on individuals to teams in the workplace. For inquiry to be truly collaborative, students need to learn how to work as part of a team as opposed to a "group".

It can be difficult to manage teamwork in the classroom; especially if there are two or more dominant personalities on the same team. Furthermore, having two or more shy, quiet students on the same team can create issues as well.

Also,. Finding a balance between mingling different personality types and creating teams with like-minded students is crucial. Encouraging students to think outside the box, consider other viewpoints, and understand the importance of collaboration are important. Student hesitation can arise for a variety of reasons – these include preconceived ideas about group work, insecurity, or simply having bad past experiences. Whatever the case may be, care and compassion are important qualities to have when managing teamwork and collaboration in the classroom.

Lack of focus and organization: In order for students to be successful with inquiry learning, they need to be able to organize themselves. They need to manage the various tasks and activities they have set out for themselves. This requires planning and coordination, which some students struggle with. Without the ability to stay organized, they will surely run into problems.

Although students may be excited about the prospect of taking control of their learning, they can become overwhelmed quickly. This has definitely been a problem with inquiry learning for me in the past. Keep in mind that students are not typically asked to manage several tasks and processes at once in their traditional educational activities. Being responsible for many aspects of their learning journey can cause a lot of stress. Teachers need to manage their students' expectations and check-in regularly with them, otherwise these common problems will bubble up.

Poor standardized testing performance. When too much time is dedicated to student inquiries, there's always the risk that important "core" topics could be left out. Naturally, this hurts standardized testing performance. And in a world where standardized exams play a key role in school accreditation and funding, this can become a real problem.

Student embarrassment**.** In inquiry-based learning, students are required to speak up and participate. For the most part, this is a good thing. However, there's also the risk of embarrassing students who may not be quick thinkers (or who suffer from learning disabilities and processing issues).

Teacher unpreparedness. For certain teachers, inquiry-based learning is too haphazard. It prevents them from being able to prepare properly, which hurts their ability to engage students on a meaningful level. And any time a teacher is unprepared, the classroom suffers as a result.

Problem-based learning

Problem-based method is 'problem first learning' Spencer & Jordan, (1999). It is the problem, usually set by an instructor, which defines what is to be learned. Curriculum content (in what is sometimes called 'pure PBL'), or course or assignment content (in 'hybrid' forms of PBL), is organized around problem scenarios, rather than subjects or topics Dahlgren & Oberg, King, (2001). Students, normally work in groups, then engage with the problem scenarios and decide for themselves what information and skills they need to resolve the situation, or questions, effectively. The focus is on students determining their own learning needs and independent during enquiry. Faculty maintains a distance, keeping a watching brief on group dynamics, direction, and progress. This requires an active, aware and respectful form of co-learning, breaking down the usual dichotomy between students and faculty Le Heron et al., (2006).

Since problems do not respect disciplinary boundaries, PBL often involves collaboration between disciplines. It is certainly likely to require students to integrate knowledge from different fields within disciplines. Such experiences are said to enhance means of managing or

synthesizing knowledge, rather than attempting to assimilate content before entering employment. Jenkins (1985) drew attention to this distinction as the difference between 'drawing out' and 'filling up'. However, in the first major international survey of good teaching practices in geography Gold et al., (1991)

According to Barron and Darling-Hammond (2008), problem-based method involves students working in small groups to "explore meaningful problems, identifying what they need to know in order to solve the problem, and coming up with strategies for solutions" (p. 43). Unlike many textbook word problems commonly found in math, these problems are realistic in that they are ill-structured, offering the possibility of multiple solutions and methods to solve the problem

Problem based method is a pedagogical strategy that uses open ended / ill-structured problems that mirror real-world problems. The authenticity of the problems helps students to transfer their knowledge and skills beyond the classroom, preparing them for the workplace and life in a rapidly changing world. The open-ended nature of problems gives students the flexibility to approach it from different angles, to take different thematic sidelines according to their personal interests. This gives them control of the learning process, capturing their interest and motivating them to learn.

With regards to this teaching approach, Lewis et al. (1998) emphasizes that the act of posing problems is integral to the process of solving problems. Finding or posing problems is a creative endeavor that can occur prior to, during, or after the act of problem solving. By keeping the problem definition open, the students can "frame and reframe" their perspective on a problem so they reach "goal clarity". Educational psychologists have discovered that solving a problem is a back-and-forth (recursive) process, not a linear one (Pea, 1985). In this way the student takes ownership of the problem thus enhancing their engagement and responsibility for the learning process.

The project base method was initially developed for learning in the applied disciplines of medicine and engineering in countries such as Canada and New Zealand because doctors and engineers spend their professional lives toying with problem scenarios. In so doing, they need the ability to draw together the insights from different chapters of the textbook, because organ systems, for example, are not independent but are all part of the one human body. The abilities of medical students and a desire to improve their capacity to relate knowledge learned to the problems with which patients presented Schwartz et al., (2001). In other words, medical students need both knowledge and the ability to integrate it, needs exacerbated by the speed of

change in that knowledge. Also, much can be said of the education of geography students, many of whom will enter careers that are not related to their expertise. For these students, the ability to learn as self-starters in new situations is clearly vital, and they have "little need for content-driven instruction" in STEM. Wu & Fournier, (2000). Core competences are vital, but need to be understood sufficiently well to be applied in different situations, and adapted as knowledge and the methods used to construct it evolve. What matters, then, is the ability to 'learn to learn' Duch, (1995), rather than what is actually learned or taught Healey, (2005).

Problem-based learning (PBL) is perhaps the most innovative instructional method conceived and implemented in education. It aims to enhance students' application of knowledge, problem solving skills, higher-order thinking, and self-directed learning skills. Its implementation began in medical education (Barrows and Tamblyn, 1980,) (Schmidt, 1983), and then gradually spread to various disciplines in higher education and K-12 education settings (Barrows et al/., 2000)

Problem based learning is a popular learning strategy use to increase student engagement commonly seen in inclusive STEM schools is focus on investigating, explaining, and solving authentic, real world problems (LaForce et al., 2017). Problem-based learning is a student-centered pedagogical approach that combines the inquiry approach and problem-solving process (Etherington, 2011). Most often problem-based learning opportunities take a shorter duration and the ouTput is usually a prototype of the solution envisage The problems have a different variety of practices in problem-based learning; ill-structured problems or complex scenarios that can be adapted to students' cognitive development (Du et al., 2008). Problem based learning differs with project-based learning in that with pbl learners are confronted with a problem and they start brainstorming on how to come about the solution whereas with PJBL learners begin by asking open ended questions which lead to the problem before they start looking for solutions. Learning with PBL occurs when students go through three steps: What do they know? What do they need to know? and how can they find out what they need to know.

Though originally developed in medical schools, problem-based learning (PBL) is a term used for instructional strategies that encourage students to conduct their own research, integrate theory and practice, and apply learned knowledge (Savery, 2006)

More specifically, in order to increase the meaningfulness of the content, a PBL curricula is typically designed around specific problems that would be similar to problems 54 students may encounter in their future jobs. According to Barrows and Kelson (1995), PBL was designed to help students construct a knowledge base, develop problem-solving skills, develop self-directed

learning skills, become effective collaborators, and become intrinsically motivated to learn. In PBL, teachers play the role of supporters and do not provide information related to the problem or any specific guidance (Savery, 2006). They simply coach students with suggestions for further inquiry while students pursue their own solutions to the problem. Lastly, to promote active intellectual and social engagement, PBL activities are typically conducted in small, collaborative groups (Mergendoller, Maxwell, & Bellisimo, 2006).

Research indicates that small group discussions and debates in PBL activities may enhance problem-solving skills. Slavery and Duffy (1995) suggested the following principles of PBL: anchor all learning activities to a larger task or problem, support the learner in developing ownership for the overall problem or task, design an authentic task, design the task and the learning environment to reflect the complexity of the environment they should be able to function in at the end of learning,

give the learner ownership of the process used to develop a solution, design the learning environment to support and challenge the learner's thinking, encourage testing ideas against alternative views and alternative contexts and provide opportunity and support for reflection on both the content learned and the learning process.

Gudzial et al. (1997) consider the two most important aspects of problem-based learning to be the authentic real-world problems and students reflection on their experiences.

The teacher's role changes from the provider of content to the facilitator of the learning process. Teachers present students with authentic problems and provide an environment where students can explore their ideas through research, discussion and reflection. The student has an active role identifying and locating resources, gathering and evaluating information.

The key characteristics of PBL are:

Problem focused: learners begin by simulating the process of solving an authentic and well-structured problem

Problem structured content: the content and skills are structure around authentic problems fostering a reciprocal relationship between knowledge and the problem itself.

Student centered self-directed learning: students take the responsibility for generating objectives self-regulating their learning process and accessing their own learning materials.

Self-reflective: students monitor their understanding and adjust learning strategies accordingly.

The role of the teacher in problem-based learning is to: Guide and support learners to actively construct their own learning, as opposed to providing information t Allow learners to take the lead, and scaffold by observing, noticing, reflecting and responding Personalize learning,

connecting with learners' individual styles and creativity, and providing opportunity for experience.

Allow learners to work in multiple directions, guiding students through questioning Implement multifaceted assessment through meaningful, 'connected' contexts throughout a program

The stages involve in PBL are:

- **Identification of the problem**: learners are presented with a complex real-world problem or scenario. They are group to understand the problem, identify the key issues and develop a shared understanding of the challenge.
- **Research and investigate:** learners at this phase gather relevant information and data so as to explore relevant solutions. They conduct research individually and collaboratively to deepen their understanding of the problem.
- **Analysis and discussion:** at this stage, learners analyze the information they have gathered and discuss potential approaches to solving the problem. They critically evaluate idears, identify knowledge gaps and formulate hypothesis.
- **Develop a solution:** learners work together to develop a solution or an approach to address the problem. It involves generating multiple ideas, evaluating them and refining the best solution.
- **Present and defend**: the different groups involve present and defend their different solutions. they organize their findings and rehearse their presentation.
- **Reflect and evaluate**: this is the last phase in which students reflect on the learning process, discuss challenges face and proposed solutions. They equally receive feedback from their peers and instructors who assess and evaluate the overall experience. The above stages of problem-based learning are often iterative with students revisiting earlier stages as they refine their understanding and solution. This cyclical process allows for deeper learning and the development of critical thinking and problem-solving skills.

Benefits of problem-based learning

PBL is one of the most effective teaching methods because it provides students with learning outcomes through critical thinking to find a solution. It provides benefits to both teachers and students. A teacher can manage his/her classroom effectively, and students can work actively on their own (Center for Teaching Innovation, n.d.). According to several studies, a teacher

who organizes and develops a well-designed PBL topic will provide students with the opportunity to develop their skills related to:

Teamwork: Students will strongly cooperate as a team to solve a problem. An assigned case study has to be solved in one line on their way; thus, they need to work actively to reach the target result. PBL generally encourages students to improve their ability to collaborate and work well in small groups (Ahamad et al., 2017; Azer, 2001)

Managing projects and holding leadership roles: Students will have chances to lead a group. Reading and discussion are the primary ways that students discover leadership (Bridges & Hallinger, 2009). In a group discussion, there should be a leader. He/she is the one who can hold the group together to know the way, to go the way, and to show the way (CTI, n.d.). He/she is like a referee making a reliable, reasonable, and responsible decision. Other members will find out the answers differently to solve the problems, so the group has to have a leader to decide which answers/information are the best to unlock the concepts of the problems

Oral and written communication: It is their time to make friendly communication with other students through sharing their ideas with each other in the group discussion. As they have more opportunities to practice using the language for real-world communication, students in PBL classrooms can develop their social skills (Azman & Shin, 2012). It is a great time for them to improve and develop their thinking by getting others' opinions in their group, and they can evaluate or rethink afterward

It is always helpful and worthwhile to have more ideas outside of their brainbox. When students present their findings to their peers, effective PBL problems help students develop their communication skills (Ahamad et al., 2017).

Self-awareness and evaluation of group processes: Students will learn more about themselves through their cooperation and sharing of their thoughts. The group process and self-knowledge, in the opinion of the students, are their most valuable learning experiences (Fenwick, 2010). They will learn about their strangeness and weaknesses through solving problems. Moreover, they will know about how their group members are; they can find out who works hard, works smart, and gives hands intensively in the process of group work.

Independent working: On the assignments to look for information, students may work independently (Azer, 2001). They have their own self-leadership in their decision to reach the

target to solve problems. In the group discussion, they can also lead their thoughts by sharing their perspectives.

Critical thinking and analysis: PBL definitely promotes critical thinking and analyzing skills. Students will have chances at this stage to unlock their potential and discover their productive skills in solving problems. They will be able to work out more on their brain and practice it in order to master their analytical and thinking capacities since their group discussions help them develop their critical thinking skills (Yuan et al., 2008).

Explaining concepts: Students will be expected to work hard on a deep understanding of the concepts of the problems. The development of students' proficiency through PBL depends equally on conceptual and procedural understanding (Ahamad et al., 2017). They need to find ways and tools to research reliable information to gain a deeper understanding. Then, students can explain what they have just explored.

Self-directed learning: As PBL is a student-centered approach, students are required to study and work on their own to reach the target objective. PBL can help students become more self-directed learners and launch a growth process for lifelong learning (Malan & Ndlovu, 2014). This process can help students get more action in the classroom rather than having to listen to the teacher all the time.

Applying course content to real-world examples: Teachers can engage their students with real-world problems. They can present and teach students what problems can exist in their real lives or someone else’s life.

Finding real problems can be difficult

Teachers can find it difficult to mark and design the problems that work best with PBL (Armitage et al., 2015). Once a teacher chooses a problem-based case, he/she has to make sure that it is a real-world problem that can help students identify its roots and target their goal to solve the given problem (Erdogan &Senemoglu, 2014). PBL courses are also still connected to the school's standards and curriculum. A teacher must ensure that students can spot potential issues because doing so gives them a chance to develop their metacognitive awareness of the course outcomes (Downing et al., 2008). They can identify the source of a problem and then propose solutions. Choosing the right topic helps ensure that students understand that PBL is both personally invented and defined. It is also a deeply educational method, as it is all about real problems, real solutions, and real learning.

Facing our ignorance of the situation PBL has the potential to remove us from the spotlight and make us uncomfortable when selecting and creating a course (Wheeler et al., 2016). The issues or technical knowledge that learners are facing may not be something we are familiar with or understand well. This is a particular challenge that we, as teachers, must take into account when planning or creating problems for the lesson. During the classroom activity, the teacher and the learners might not be aware of the intended solution.

Getting familiar with PBL this is a significant issue for an instructor who wants to get deeply educated on PBL. It will become more effective in the classroom if teachers get well-versed in resources and information searching through various sources (Tick, 2007). Teachers are often required to increase or improve their professional development to be more competent in applying PBL. According to Ahamad et al. (2017), given that the students were unfamiliar with PBL, it is also important to take note of this method. As a result, even though the teacher clearly implemented the PBL lessons, it appears that the student required more assistance and facilitation from the teacher.

Recognizing and accepting failure in applying PBL is not a bad issue (Fatokun & Fatokun, 2013). Instead, it offers a fantastic chance for the teacher and students to consider the implications of their real-world problem-solving decisions as well as the teacher's problem-solving preparation (Akcay, 2009). In order to solve every issue that they come across, students will not always be able to find the right key or hint. Failure is just a piece of the process toward success (Tick, 2007). Students need to understand that failure is not the worst part of accepting and giving up the goal that they would like to achieve; it is often a key to the process of success. They must understand that PBL is a way of learning, not an exam.

STEM education

STEM is an acronym which stands for Science Technology, Engineering and Mathematics. It is a recent and most advancing field in education which integrates four disciplines: science, technology, engineering and mathematics. STEM education or STEM learning refers to programs that are designed to help students gain required skills in the job market. This includes a variety of soft skills such as critical thinking, problem solving, creativity, Team work, digital literacy, communication and problem solving. It is not a separate discipline but thought as an integration of the four disciplines to adapt learning based on real life situations through children learn the above-mentioned skills.

Its origin can be trace in the United States of America during the 'space race' as stated by (Marick, 2016). STEM Education was originally called Science, Mathematics, Engineering and Technology (SMET) (Sanders, 2009), and was an initiative created by the National Science Foundation (NSF). This educational initiative was to provide all students with critical thinking skills that would make them creative problem solvers and ultimately more marketable in the workforce. The first wave of science, technology, engineering, and math began in 1957 when the Russian satellite Sputnik was successfully launched into space This was the first satellite to orbit the Earth.

The United States leaders, citizens, and scientific community were astonished by this massive technological achievement. They were caught off guard and came together as a nation in an effort to catch up with the Soviets. This marks the beginning of what is now known as the "space Race" (Marick, 2016). In this light, STEM education was intensified in the US to meet up with technological advancements and prepare a strong STEM workforce for the country (US department of education, 2020).

The four strands of STEM: Science, Technology, Engineering, and Mathematics, have been staple forms of all students' academic careers; particularly science and mathematics. They are defined as:

Science: the systematic study of the nature and behavior of the material and physical universe, based on observation, experiment, and measurement, and the formulation of laws to describe these facts in general terms (Science, 2012).

Technology: the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment, drawing upon such subjects as industrial arts, engineering, applied science, and pure science (Technology, 2012).

Engineering: the art or science of making practical application of the knowledge of pure sciences, as physics or chemistry, as in the construction of engines, bridges, buildings, mines, ships, and chemical plants (Engineering, 2012).

According to Cameroon primary school curriculum (2018) Science and Technology is penetrating every aspect of societal life and therefore has become an important component in the learning-teaching programs at every level of education. It enables learners to understand themselves and their environment as well as adapt to the ever-changing world in which they live. The teaching of Science and Technology develops the spirit of curiosity, creativity and innovation. Through Science and Technology, learners will be able to predict and analyze causes and effects of phenomena and use scientific approaches to solve emerging problems.

These skills will be developed in Health Education, Environmental Science as well as in Technology and Engineering.

Mathematics: a group of related sciences, including algebra, geometry, and calculus, concerned with the study of number, quantity, shape, and space and their interrelationships by using a specialized notation (Mathematics, 2012). According to the Cameroon primary school curriculum (2018) Mathematics develops the learner's creativity, initiative and problem-solving skills. It equally develops logical and inferential thinking, the ability to deduce and visualize in space and time. Through mathematics, the learner improves his/her knowledge of science, technology, agriculture and engineering. It is also necessary for financial literacy and relevant to most forms of employment. Mastering Mathematics entails the acquisition of knowledge, skills and attitudes as well as problem solving skills related to the different integrated learning themes. Primary School learners need these in computation, logical thinking and problem solving to construct knowledge and understand the world around them.

STEM education advocates for learner centered approaches in education such as project-based learning, problem-based learning, hands on minds on minds on, cooperative learning and inquiry based learning (Tallar G. 2022). the use of such instructional strategies enable learners to acquire skills such as collaboration, communication, creativity, critical thinking and problem solving which are very necessary for integration in the 21st century.

STEM education requires learning that takes place in an authentic environment such that learners can be confronted with real life problems which will prob them to think, collaborate as they work in groups to face the challenge. The role of the teacher in STEM education is a facilitator whose role is to guide, create mix ability groups, provide learners with resources and provide hurdle help where they are stuck. Learners should be allowed to ask open ended questions, interact, explore and try out different solutions.

STEM education is crucial for both individual success and societal progress. It equips you with the skills to land in-demand jobs, think critically and solve problems, and drive innovation that shapes the future. From understanding the world around you to contributing to its advancement, STEM empowers you to be a well-rounded and impactful member of society.

Job market: STEM fields are growing rapidly, with many new jobs being created. A strong foundation in STEM can make you more competitive in the job market and qualify you for higher-paying careers.

Boast soft skills: STEM education teaches you how to think critically, solve problems, and analyze data. These skills are valuable in any field, not just STEM-related ones communication skills, critical thinking skills, problem solving skills, creativity and other soft skills that boast

employability are developed in STEM education from early childhood. During STEM education, learners need to interact with team members, communicate their thoughts, communicate their thoughts and explore new ideas. Even when kids carryout individual work in STEM, they build cognitive skills and overall brain health.

Innovation: STEM is the driving force behind innovation. From new medical technologies to sustainable energy solutions, STEM fields are constantly developing new ways to improve our lives. Stem learners are potential job creators thus reducing the rate of unemployment and boasting entrepreneurship.

Fosters curiosity: STEM education helps learners to be curious. It enables them to develop more scientific questions that enable them to carryout investigations. By carrying out learning in real life scenarios and allowing children to be autonomous, it is certain that their curiosity will be boasted.

Empowered public: A basic understanding of STEM concepts is essential for making informed decisions about the world around you. This includes things like understanding climate change, the safety of new technologies, and the ethics of artificial intelligence. All of these are key aspects of a positive future, which only increases the importance of stem education.

Media and technological literacy: media literacy refers to one's ability to adapt to new technologies rapidly as well as using them properly. With the t in STEM which stands for technology, kid's access to STEM will enable them to be technology literates soonest. They will be able to sort out information that is valuable and make appropriate discretion. STEM education has varied advantages thus it is a major call for concern for education in the 21st century.

STEM Skills

STEM skills are skills which enable learners or people to be able to suit professionally and other wise to the demands of the 21st century. Some of these skills include; creativity, problem solving, digital literacy, collaboration, global awareness and data analysis. Also, 21st Century Skills are defined as a broad set of knowledge, skills, work habits, and character traits that are believed to be critically important to success in today's world (21st Century Skills, 2016). These are skills that teachers are working to include in their classrooms to set up their students for success in their post graduate and professional lives thus learners need not only knowledge but equally skills to face the challenges of the modern world. They include critical thinking, problem solving, research skills, creativity, perseverance, public speaking, leadership,

collaboration, technology literacy, data analysis, social justice, global awareness, and reasoning (21st Century Skills, 2016). Many of these skills align closely with STEM education. Both STEM education and 21st Century Skills strive to prepare students for success in their pursuit of higher education or careers.

Critical thinking

Paul and Elder (2008) define critical thinking as the process of conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered from or generated by observation, experience, reflection, reasoning, or communication. They state that students who think critically are able to gather and assess information before coming to thought out conclusions. They think open-mindedly and recognize that others may have opinions that differ from their own. Instead of shutting down other ways of thinking, they listen thoughtfully to other's thoughts before forming an opinion. Critical thinkers are able to look at a situation from many points of view and fully consider all opinions before making a decision. Critical thinking is a skill that must be taught to students through natural sciences or other disciplines to prepare them to be successful in life and opinion (Cahyono, 2017; Alsaleh, 2020; Saenab, 2020) Critical thinking is the ability to analyze information and make logical conclusions. It's important for STEM students because it allows them to solve complex problems, which can be a large part of many careers in science and technology. Critical thinking also helps students learn how to apply their knowledge to new situations, which can help them advance in their field or find success in other areas.

Collaboration

Collaboration equally referred to as teamwork is an essential part of success inside and outside of the classroom (Johnson, A., 2017). It requires working collaboratively with others in order to reach a common goal. Developing this skill at a young age allows students to become effective communicators, actively listen to and participate in conversations with their peers, work with others to come to an agreement, and accountability. When working with a team it is crucial that all members work collaboratively and hold each other accountable. This allows projects to run smoothly and helps everyone to achieve their goals. Instilling the importance of teamwork and personal accountability at a young age allows students to be more successful through the rest of their education and careers.

Creativity

Creativity is the ability to create something concrete which is novel, relevant and effective. It often begin by identifying a good problem, and brainstorming solutions which are relevant to

solving real life problems. According to (Cropley. 2020) Creativity involves doing these things in ways that are, on the one hand, novel and on the other, effectiv*e* in achieving a desired result. Genuine creativity requires a further element over and above mere novelty. It must be effective. Otherwise every novelty: A product or response must be relevan*t* to the issue at stake and must offer some kind of genuine solution. In addition to being effecti*ve* and relevant, creativity has an ethical element, it should be something which is eco-friendly, human friendly and sustainable.

Communication

Communication refers to the ability to effectively convey information both verbally and in writing. This skill enables learners to be able to share their ideas and viewpoints during group work activities with their peers and to equally share their presentation with a large audience. This skill also looks at the ability of learners to present the work such as project plans in writing.

Problem solving

Problem solving is the act of defining a problem, determining the **c**ause of the problem, identifying, prioritizing and selecting alternatives for a solution and implementing a solution (Kaplan, 2023). An effective implementation of STEM education in the classroom using appropriate teaching methods will enable learners to acquire this skill equip them to face every challenge encountered in everyday life. Problem-solving skill is one of the fundamental human cognitive processes. Whenever students face a situation where they do not know the way to complete a task, the problem occurs. Problem-solving is a process, which involves systematic observation and critical thinking Sto find an appropriate solution or way to reach the desired goal. The framework of problem-solving consisted of two major skills: observation and critical thinking skill. Observation skill refers to collecting data, understanding and interpreting the meaning of the information using all the senses. Critical thinking involves the individual's ability to do the following: conceptualize, reason logically, applying strategy, analytical thinking, decision making and synthesizing to solve any problem. The above-mentioned skills are very important and necessary for integration in the 21st century.

Theoretical framework

Constructivism is a learning theory which enables learners to construct their knowledge on their own. It is a learning theory that emphasizes the active role of learners in building their own understanding. Rather than passively receiving information, learners reflect on their experiences, create mental representations, and incorporate new knowledge into their schemas. This promotes deeper learning and understanding.

Constructivism is ‘an approach to learning that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner’ (Elliott et al., 2000, p. 256). Constructivism’s central idea is that human learning is constructed, that learners build new knowledge upon the foundation of previous learning.
This prior knowledge influences what new or modified knowledge an individual will construct from new learning experiences (Phillips, 1995).
The second notion is that learning is an active rather than a passive process.
The passive view of teaching views the learner as ‘an empty vessel’ to be filled with knowledge, whereas constructivism states that learners construct meaning only through active engagement with the world (such as experiments or real-world problem-solving).

Information may be passively received, but understanding cannot be, for it must come from making meaningful connections between prior knowledge, new knowledge, and the processes involved in learning. John Dewey valued real-life contexts and problems as an educational experience. He believed that if students only passively perceive a problem and do not experience its consequences in a meaningful, emotional, and reflective way, they are unlikely to adapt and revise their habits or construct new habits, or will only do so superficially.
Learning is a social activity – it is something we do together, in interaction with each other, rather than an abstract concept (Dewey, 1938). Vygotsky (1978) believed that community plays a central role in the process of “making meaning.” For Vygotsky, the environment in which children grow up will influence how they think and what they think about thus, all teaching and learning is a matter of sharing and negotiating socially constituted knowledge. For example, Vygotsky (1978) states cognitive development stems from social interactions from guided learning within the zone of proximal development as children and their partners co-construct knowledge.

Each individual learner has a distinctive point of view, based on existing knowledge and values. This means that same lesson, teaching or activity may result in different learning by each pupil, as their subjective interpretations differ. This principle appears to contradict the view the knowledge is socially constructed. Fox (2001) argues that although individuals have their own personal history of learning, nevertheless they can share in common knowledge, and experiences which will help wholly to ensure the effective acquisition of competences, knowledge and attitudes for the overall learning process.
However, though education is a social process powerfully influenced by cultural factors, cultures are made up of sub-cultures, even to the point of being composed of sub-cultures of

one. Cultures and their knowledge base are constantly in a process of change and the knowledge stored by individuals is not a rigid copy of some socially constructed template. In learning a culture, each child changes their culture. This will have a strong impact on the teaching learning process as learners drop old habits and beliefs and acquire new ones, thus the impact of collaboration in a constructivist classroom.

In elaborating on constructivists' ideas, Arends (1998) states that constructivism believes in the personal construction of meaning by the learner through experience and that meaning is influenced by the interaction of prior knowledge and new events. The constructivist theory posits that knowledge can only exist within the human mind, and that it does not have to match any real-world reality (Driscoll, 2000).Learners will be constantly trying to develop their own individual mental model of the real world from their perceptions of that world as they perceive each new experience, learners will continually update their own mental models to reflect the new information, and will, therefore, construct their own interpretation of reality. There are three types of constructivism: Cognitive constructivism, based on the work of Jean Piaget; social constructivism, based on the work of Lev Vygotsky; and radical constructivism.

In constructivist classrooms, students interact in many ways as they learn in groups and not in isolation. They actively cooperate to solve problems, test hypothesis discuss experiment debate and even create their own unique experiences, though the role of learners is center here, the role of the teacher is indispensable as he acts as a facilitator in the teaching learning process. . Vygotsky (1978) also emphasized the role of the co-constructed process where the learners interact and collaborate in solving problems. Constructivism, which is the backbone of PBL, shapes the cognitive process where students incorporate new experiences to their existing experiences (Piaget, 1954) and become users of information in a student-centered environment. Some principles of constructivism are:

Learners bring unique prior knowledge, experience, and beliefs to a learning situation this prior knowledge influences what new or modified knowledge an individual will construct from new learning experiences (Phillips, 1995). These experiences brought by learners in to the learning environment gives them different perspective to approach a learning situation thus the need for collaboration in the learning process so as to harmonize these difficulties. Also, the fact that learners enter in to the learning situation with diverse views and perspective brings the need for individualize teaching strategies so as to meet with the diverse views of learners.

Knowledge is constructed uniquely and individually in multiple ways, through a variety of authentic tools, resources, experiences, and contexts. Learning is both an active and a reflective process. The passive view of teaching views the learner as 'an empty vessel' to be filled with

knowledge, whereas constructivism states that learners construct meaning only through active engagement with the world (such as experiments or real-world problem-solving). Constructivist also emphasize on the use of teaching methods whereby learners learn by doing such as hands on minds on method, experiential learning and other active learning strategies.

Information may be passively received, but understanding cannot be, for it must come from making meaningful connections between prior knowledge, new knowledge, and the processes involved in learning John Dewey valued real-life contexts and problems as an educational experience. He believed that if students only passively perceive a problem and do not experience its consequences in a meaningful, emotional, and reflective way, they are unlikely to adapt and revise their habits or construct new habits, or will only do so superficially.

Learning is a developmental process of accommodation, assimilation, or rejection to construct new conceptual structures, meaningful representations, or new mental models.

Social interaction introduces multiple perspectives through reflection, collaboration, negotiation, and shared meaning. Learning is a social activity – it is something we do together, in interaction with each other, rather than an abstract concept (Dewey, 1938).

Vygotsky (1978) on the other hand believed that community plays a central role in the process of "making meaning." For Vygotsky, the environment in which children grow up will influence how they think and what they think about thus, all teaching and learning is a matter of sharing and negotiating socially constituted knowledge.

Vygotsky (1978) states cognitive development stems from social interactions from guided learning within the zone of proximal development as children and their partners co-construct knowledge.

Learning is internally controlled and mediated by the learner. This implies that the learner is not an empty vessel without any content but contains unshaped knowledge which must be build up by the more knowledgeable order.

The teacher is the more knowledgeable order (MKO) according to Vygotsky theory who guides and mentors the learners until they achieve their learning goals without which learners won't be able to cross the zone of proximal development (ZPD) as stipulated in this theory. 'The distance between the actual development level as determine by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers' (Vygotsky 1978 p.86)

.Also, Vygotsky emphasize the role of society in learning that is there must be interaction between man and the society for learning to take place. The zone of proximal development is

the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky 1978). That is ZPD is the distance between what the child knows and what he\she does not know. Vygotsky believed that when a student is in the zone of proximal development for a particular tasks, providing the appropriate assistant will give the student enough boast to achieve the task. Vygotsky stipulated that to help a person move through the zone of proximal development, the following should be done in the learning process

The presence of someone with skills and knowledge beyond the learner (a more knowledgeable order).

Social interactions with a skillful tutor that allow the learner to observe and practice their skills.

Constructivism is a way of teaching where instead of just telling students what to believe, teachers encourage them to think for themselves. This means that teachers need to believe that students are capable of thinking and coming up with their own ideas. Unfortunately, not all teachers believe this yet in America.

The primary responsibility of the teacher is to create a collaborative problem-solving environment where students become active participants in their own learning.

From this perspective, a teacher acts as a facilitator of learning rather than an instructor.

The teacher makes sure he/she understands the students" preexisting conceptions, and guides the activity to address them and then build on them (Oliver, 2000).

Scaffolding is a key feature of effective teaching, where the adult continually adjusts the level of his or her help in response to the learner's level of performance.

In the classroom, scaffolding can include modeling a skill, providing hints or cues, and adapting material or activity (Copple & Bredekamp, 2009).

Scaffolding, or supportive activities provided by the educator or more competent peer, to support the student as he\she is led through the zone of proximal development.

Scaffolding consist of the activities provided by the educator or a more competent peer to support the student as he\she is led through the zone of proximal development. To support students in this process Darling-Hammond (2008) and Barron et al. (1998) argued that scaffolding activities, frequent opportunities for formative assessment, as well as powerful guiding questions are vitally important for ensuring inquiry-based projects to lead to deep understanding

Although there is widespread disagreement in the field as to what constitutes a scaffolding activity, in general it involves tools, strategies, and guides to support students in gaining levels of achievement that would not be otherwise possible. Simons and Klein (2006) argued that an effective scaffold involves bracketing out elements of a task initially beyond the learner's capability in a way that allows the learner to concentrate upon and complete only those elements that are within their range of competence. Similarly, Pea (2004) argued that scaffolds involve a range of instructional measures including "constraining efforts, focusing attention on relevant features to increase the likelihood of the learner's effective action, and modeling advanced solutions or approaches" Research suggests that scaffolding activities positively impact problem solving (Cho & Jonassen, 2002), reflection (Davis & Linn, 2000), research assistance (Brinkerhoff & Glazewski, 2004), concept integration (Davis & Linn, 2000), and knowledge acquisition (Roehler & Cantlon, 1997).

According to Wood, Bruner and Ross (1976), scaffolding is a process that enables a child or novice to solve a task or achieve a goal that would be beyond his unassisted efforts. As they note, scaffolds require the adults controlling those elements of the tasks that are initially beyond the learner's capability, thus permitting him to concentrate upon and complete only those elements that are within his range of competence.(Wood et al.1976) named certain processes that aid effective scaffolding which are: gaining and maintaining the learner's interest in the task, making the task simple, emphasizing certain aspects that will help with the solution, Control the child's level of frustration and demonstrate the task.

It's essential to note that the MKO isn't necessarily an adult or a teacher. It could be a peer, a younger person, or even technology or media, as long as they provide the learner with the knowledge or scaffolding needed to perform a task.

Often, a child's peers or an adult's children may be the individuals with more knowledge or experience. The relationship between the MKO and the ZPD is vital to Vygotsky's theory. The MKO assists or scaffolds the learning experience to help the learner function within their ZPD. Through this guidance, the learner can tackle and master tasks they couldn't accomplish independently.

Over time, as the learner internalizes this support and becomes more capable, the scaffolding can be reduced, and the learner can perform the task without assistance. The ZPD moves as learners acquire new skills and knowledge with the help of the MKO. In educational settings, the concepts of MKO and ZPD have inspired practices like cooperative learning, differentiated instruction and scaffolded learning experiences.

Teachers aim to identify each student's ZPD and then act as the MKO, or facilitate interactions with other MKOs, to provide the right level of support, allowing students to achieve and learn effectively.

A constructivist classroom emphasizes active learning, collaboration, viewing a concept or problem from multiple perspectives, reflection, student-centeredness, and authentic assessment to promote meaningful learning and help students construct their own understanding of the world. In a study Tam (2000) lists the following four basic characteristics of constructivist learning environments, which must be considered when implementing constructivist teaching strategies:

Knowledge will be shared between teachers and students.

Teachers and students will share authority.

The teacher's role is one of a facilitator or guide.

Learning groups will consist of small numbers of heterogeneous students.

Therefore, in such a case, knowledge is being built rather than delivered by the teacher. John Dewey, a constructivist and an advocate of inquiry-based method, states that students should actively be in engaged in the learning process. He explains: "if you have doubts about how learning happens, engage in sustained inquiry: study, ponder, consider alternative possibilities, and arrive at your belief grounded in evidence" (Dewey, 1998, as cited in Mapes, 2009, p.11). John Dewey strongly believed that students need to be reflective problem solvers and not passive learners who just memorize knowledge (Santrock, 2017).

The fundamental approach to inquiry learning is based on constructivist learning theory. Constructivist learning strategies capitalize on learning through inquiry and problem solving via critical and creative thinking. According to (Asselin et al 2003) student inquirers are encouraged to explore new ideas and understandings through personal discoveries and explorations as well as interactions with objects and with other people. Learning is enhanced through the inquirers‟ opportunity to engage in real life activities, situations and with real audience. From the theory teachers generate the facts that students: can actively build their knowledge and understanding through their inquiries and information seeking nature.

This is to develop their cognition as well as meta cognition as they absorb the information and experience changes in their affective and cognitive domains as they progress, need time to reflect on their new - found knowledge and process the information.

Honebein (1996) summarizes the seven pedagogical goals of constructivist learning environments:

To provide experience with the knowledge construction process (students determine how they will learn), to provide experience in and appreciation for multiple perspectives (evaluation of alternative solutions) to embed learning in realistic contexts (authentic tasks). Also, he emphasize on the ownership and a voice in the learning process (student-centered learning) so embed learning in social experience (collaboration) and lastly he encourage the use of multiple modes of representation, (video, audio text, etc.) To encourage awareness of the knowledge construction process (reflection, metacognition).

Jerome Bruner contributes to constructivism and is primarily concerned with making education more relevant to student needs at each stage, and he believes that teachers could accomplish this by allowing students to actively participate in the learning process (Roblyer & Doering, 2013). His theory, discovery learning, is a form of IBL and states that students are more likely to understand and remember concepts that they discover during their interaction with the environment (Roblyer & Doering, 2013). Lev Vygotsky known for his social constructivism theory explains that social interaction and critical thinking are two main ingredients of a learning process (Liu & Chen, 2010). He describes IBL as an "integral part of creating a social constructivist classroom" (Powell & Kalina, 2009, p. 244).

Empirical review

Inquiry based learning

There are many studies that have been carried out with on the effectiveness of teaching methods on the acquisition of skills in STEM education. Some of these studies are as follows; there is an abundant amount of research that shows that inquiry-based instruction is more effective than conventional instruction (Minner, Levy & Century, 2010; Nail, 2011; Satchwell & Loepp, 2002). in a study comparing the effect of an inquiry-based unit versus a traditional teaching approach in a Virginia school, Nail (2011) determined that an inquiry-based approach had a highly significant effect on the immediate understanding level of students and student retention of information. Similarly, a meta-analysis of over 130 studies found that inquiry-based instructional practices increase science and math content as well as critical thinking and problem-solving skills (Minner et al., 2010).

Hattie (2009) analyzed 205 studies through Meta analyses on inquiry-based teaching with most in science education rather than mathematics education. He found that the effects were greatest at elementary level but decreased as students progressed through their school.

Newmann et al. (1996) conducted a large study evaluating elementary, middle, and high schools that had implemented authentic pedagogy and authentic academic performance approaches in their mathematics and social studies classrooms. They sought to determine to what extent student achievement improved in schools with high levels of authentic pedagogy involving higher-order thinking, deep-knowledge approaches, and connections to the world beyond the classroom. The research team observed 504 lessons, analyzed 234 assessment tasks, and systematically sampled student work. The researchers found that environments with high levels of authentic pedagogy led to higher academic achievement among all students. They concluded that differences between high- and low-performing students greatly decreased when students who were normally low-achieving were offered authentic pedagogy and inquiry-based learning. In another study examining 2,128 students in 23 schools in Chicago, Newmann et al. (2001) found that students instructed in mathematics and writing organized around inquiry-based learning made higher progress-than-normal gains on standardized tests.

In another large study, Smith et al. (2001) focused on the impact of forms of instruction they deemed interactive on learning in technology and mathematics. After examining test scores from over 100,000 students in Grades 2 to 8 along with surveys from more than 5,000 teachers in 384 Chicago elementary schools, they found strong empirical evidence that inquiry-based teaching methods were associated with greater learning and deeper understanding among elementary students in technology and mathematics.

Project based learning

Research also supports project-based method as an effective method to increase student motivation and interest. In a recent study, Beier et al. (2019) explored whether authentic PjBL affected student attitudes and career aspirations in STEM. The researchers concluded that engaging in at least one project-based method during the first year of college led to greater STEM skills efficacy and higher levels of career aspirations in STEM subjects. While (Beier et al. 2019) focused on college project-based method opportunities, several other researchers noted similar findings at the K-12 level. For instance, in a study that measured PjBL effectiveness on third, fifth, and 10th graders classified as low in motivation, 82% of the

students agreed that the projects they participated in helped increase their motivation, and 93% noted an increase of interest in the topics involved (Bartscher, Gould & 58 Nutter, 1995)

Similarly, another study found that after students engaged in one semester of PjBL activities, their intrinsic motivation for the subject matter significantly increased (Helle, Tynjala, Olkinuora & Lonka, 2007). The existing literature suggests that students enjoy the experience of participating in authentic projects, and PjBL may impact student career aspirations and interest in STEM (Beier et al., 2019).

In another study examining Grades 4 and 5 students working on a nine-week project to define and find solutions related to housing shortages, Shepherd (1998) found that the project-learning students scored significantly higher on a critical thinking test in comparison to a control group who did not take part in the inquiry project. The project-learning students also demonstrated greater confidence in their learning.

In another study in England, Boaler (1997) examined the impact of inquiry-based learning through a longitudinal study that followed students over three years in two schools with similar student achievement and income levels. Although the study found similar gains in learning on basic mathematics procedures, a greater number of the students involved in project-learning passed the National Exam in year three than those in the traditional school. These students also developed more flexible and useful mathematical knowledge.

PBL approaches have grown of importance in STEM classrooms since it supports the integration of multiple disciplines within each project and higher-order thinking (Capraro & Slough, 2013). In a comprehensive study, Boaler (1997) observed and interviewed students in a traditional-teaching school and a PBL-based school to examine the differences in the quality of their learning. The researcher noted several differences in student attitudes and mathematics learning. For instance, while students at the traditional school noted that they found the curriculum to be boring and tedious, students at the PBL School referred to mathematics as a dynamic subject that involved investigation. Additionally, students at the PBL School outperformed students from the traditional school on the national examination and the conceptual questions the researcher provided. Most significantly, students from the PBL School developed more useful forms of knowledge and were able to apply the knowledge in a wide range of settings (Boaler, 1997)

A study led by Harwell (2007) revealed that 64% of middle school girls preferred to learn in an active way, such as by conducting experiments and through hands-on experiences. Notably and significant to this research study, strategies that incorporate active learning may increase retention in STEM knowledge and interest in pursuing a STEM-related career (PCAST, 2012)

Through the changing of learning activity in a proper way by the application of STEM Project-Based Learning, future generations are expected to develop the knowledge and thinking skill to solve the problem. Therefore, this study aimed to investigate implementing STEM Project-Based Learning on student's Problem-Solving Skills. This research used a Pre-Experiment method with a One-Group Pretest-Posttest design and essay questions as data collection tools. In this research, 30 7th-grade students at one school in Bandung, Indonesia, were chosen as the participants. The data analysis showed significant improvement between student's Problem-Solving skills pretest and post-test (N-Gain=0.73). In addition, Idea-Finding is the most significant improvement during the Fact-Finding on the lowest. Based on the result, STEM Project-Based Learning is recommended to improve students' Problem-Solving Skills since they can use their integrated knowledge to solve a real-world problem.

Also, a study carried out by Dywan, Aureola, Airlanda, and Septian (2020) to examine the effects project-based method STEM (science, technology, engineering, and math), and non-STEM-based learning models on skills. Fourth-year elementary school students' critical thinking. The population of the Gajah Mada cluster, Sidomukti district, Salatiga city, used SD Negeri Dukuh 01 Salatiga sample as an experimental group of 32 students and SD Negeri sample as a control group of 33 students. To ascertain test accomplishment, this study used a semi-experimental study design with a non-equivalent control group and required pre- and post-trial trials. An independent t-test with a significance level of 0.038 produced the results of this study. 0.05 When using SPSS 20 for Windows. This means that H1 is accepted and H0 is rejected, which has a significant effect on increasing the mean pre-test to post-test scores in the experimental group from 7.51 to 13.38.

In (Setyowati et al. 2020) study, the topic of STEM PBL became a topic for instructional content as a method of increasing students' critical thinking and awareness in a lengthy period and sustainability. Based on the feasibility test results, a score of 85 with a very strong grounding for the critical thinking ability test and a score of 97 with a strong background for the sustainability perception test. The PBL-STEM model serve as the foundation.

To enhance 4th-grade elementary school students' critical thinking skills by using the most effective science-related content and the STEM-based learning model. The findings show that STEM is taught at the high school and undergraduate levels in Indonesia,. (Sulisworo et al. (2021) through IBL. In addition, relevant research on STEM-based physics with learning media. This study has several limitations, including the fact that the main reference material used as the main research material is still limited to Indonesian research. The findings of the Indonesian language study cited in this article are not from peer-reviewed international journals.

Other researchers should use critical thinking skills to demonstrate the performance of various learning materials, learning models, and scientific bibliographies published in reputable international journals to ensure universal use.

Dywan and Airlanda (2020) investigate the impact of PJBL models or STEM-based projects (Science, Technology, Engineering, and Mathematics) on critical thinking skills. They use a sample of 32 students as the experimental group and 33 students as the control group. This research employed a semi-experimental research design with a nonequivalent control group design to determine which experimental studies should be performed before and after the others. The results of the study were collected using the independent t-test in SPSS 20 for Windows with a significance level of 0.038 & lt; 0.05, indicating that there is a significant. effect in which H0 is rejected, and H1 is accepted and that the average pre-test for the post-test in the experimental group increases by 13.38 while it increases by 7.51 in the control group. The project-based learning model is the most effective in improving the critical and problem-solving skills of 4th-grade elementary school students on science learning content.

Chu (2009) used a mixed method design to examine the outcome of an inquiry project completed by students in Hong Kong with the assistance of multiple educators. Chu's (2009) results show that the children were more motivated and academically successful compared to the control group

According to (Eja et al. 2020), 25% of students' critical thinking abilities were in the low category, 34% of students' critical thinking and creative abilities were in the medium category, and 41% of students' critical thinking abilities were in the high category. Peer assessment backs up this result, which shows 12% in the low category, 41% in the medium category, and 47% in the high category. As a result, the study's conclusion is that students' critical thinking processes during PBL learning produce excellent results.

According to (Isro et al., 2021) revealed that students could demonstrate diversity in their critical thinking skills. All aspects of all strategies and tactics fall into this category. The top category includes explanations of basic aspects, basic support, and conclusions. The first step is to define the type of intermediary. The critical thinking and collaborative abilities in relation to STEM disciplines, PBL has a relatively high average.

Problem based learning and skill acquisition in STEM education

Atheson (2004) had a study comparing three teaching methods: hands on learning, blended learning and problem-based learning on recall of facts, understanding of concepts and acquisition of critical thinking and problem solving in elementary STEM classroom. The sample of the

study was very small and not random. The author concluded there was a significant difference in students' performance in health science using the three methods as measured by the examination score. As indicated from this study the students mean score for understanding and recalling were higher in problem-based learning than in hands on minds on and blended learning.

Another review of related literature on the effect of PBL on developing nursing students' critical thinking29 showed a positive relationship between the implementation of PBL as an instructional model and improvements in critical reasoning. Many of these studies are often localized, and their results and methods—while not necessarily generalizable—provide some pedagogical value as guidelines for nurse educators in considering training frameworks to design and deliver healthcare curriculum. More rigorous research is needed to further examine the effects of PBL on student learning outcomes and performance in both academic and workplace situations.

A recent empirical study adds further evidence to the effectiveness of PBL. The authors randomly assigned groups of students to one of three conditions (PBL, lecture-based or self-study groups) and found that students in the PBL group had a higher likelihood of conceptual change, outperforming those assigned to both of the other two conditions in conceptual tests immediately after the lesson, as well as in a delayed post-test after one week.30 Although this study is useful in supporting the efficacy of PBL, the authors acknowledged that more still needs to be done to better understand the processes involved within the PBL framework that enhance learning.

In another study, Gallagher, Stepien, and Rosenthal (1992) created a problem-based course for high achieving high school students in mathematics and science. In this case problem-based instruction emphasizes presenting students with ill structured problems around the meaning and impact of contemporary scientific issues (i.e., the effect of electromagnetic fields on childhood leukemia, the health care system). Results from the study showed significant changes in students' ability to problem solve as reflected in a much stronger ability among students in the problem-based class to describe a process for finding a solution to an ill-defined problem that they had never encountered. This conclusion was reached through comparing gains made in relation to a pretest and posttest for the 78 students involved in the problem-based course. The researchers then compared these results to a comparison group that did not participate in the problem-based learning course.

In a meta-study, Dochy, Segers, Van den Bossche, and Gijbels (2003) examined 43 peer-reviewed empirical studies on problem-based learning undertaken in classrooms. They found that problem-based learning has a strong positive effect on students' skills. This was shown through both a vote count, as well as by the combined effect size. The one area where there was a tendency towards a negative result was related to the effect of problem-based learning on student knowledge. However, they noted that this result was greatly influenced by two studies. For knowledge-related outcomes their results suggest that the impact on learning increases when students engage in problem-based learning for a second time.

In a study Barron et al, (1998) also investigated sixth-grade students, presenting one class with a problem-solving planning activity prior to beginning their projects, while in another class students were not offered the framing problem-solving task. Their results indicated that students in the problem-solving classroom conditions were better able to apply the targeted math concepts and had higher achievement than those without these conditions in place

CONCEPTUAL DIAGRAM

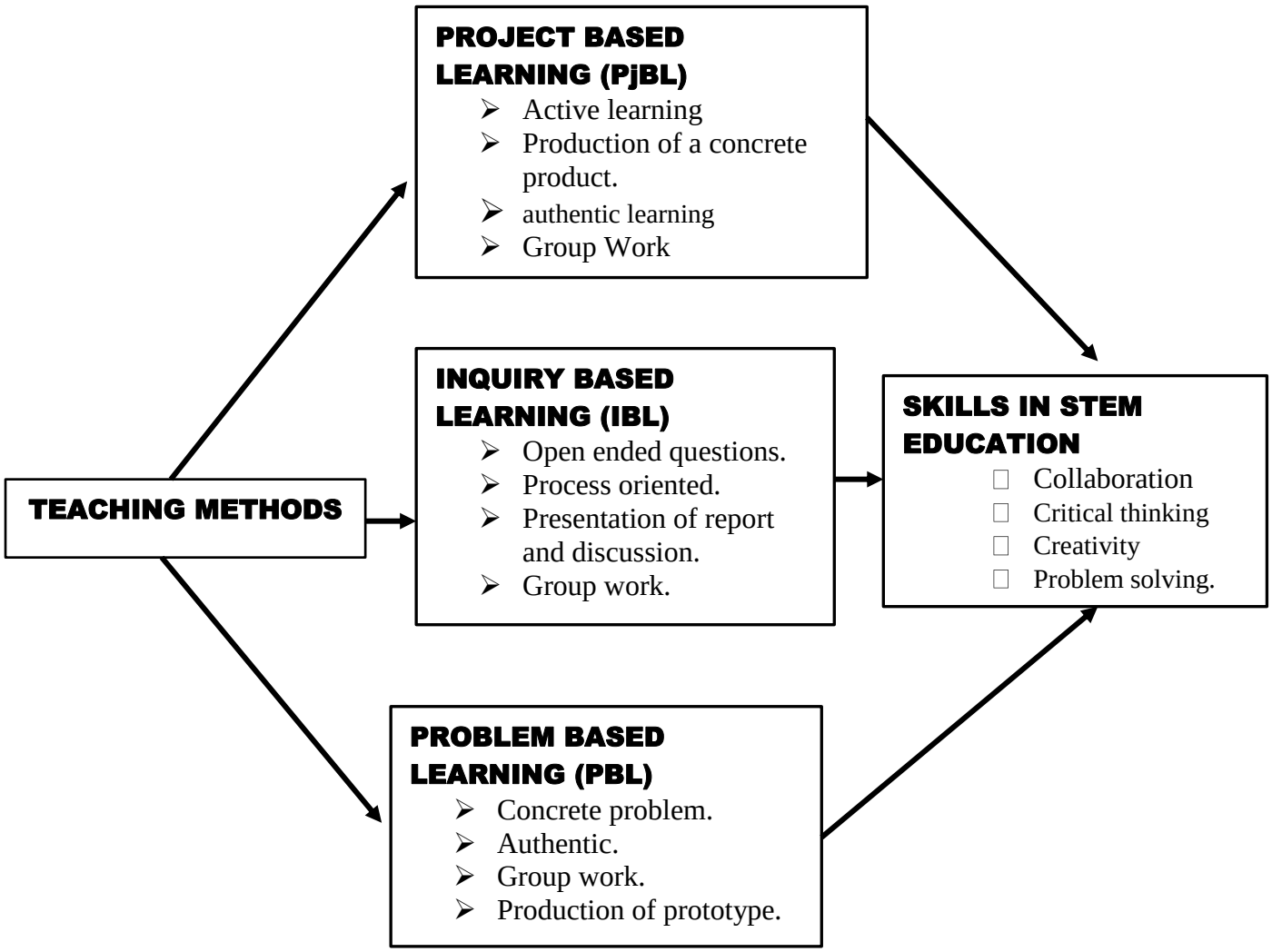


Figure 1: conceptual diagram

Source: Fieldwork 2024

The conceptual diagram shows the interrelationship between the dependent and independent variable from the diagram the use of teaching methods effectively will increase the acquisition of skills in STEM education why the ineffective use of teaching methods will decrease the acquisition of skills in STEM education. If project based learning is effectively use in the teaching of STEM education, it will facilitate the acquisition of STEM skills, if inquiry based learning is effectively applied in the teaching learning process in STEM disciplines it will facilitate skill acquisition in STEM education likewise if problem based learning is effectively use in the teaching of STEM disciplines it will positively equip learners with skills in STEM education.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter covers the research deign, population of study, target and accessible population, instrument of data collection, reliability, validity administration, data analysis technique and ethical consideration.

Research design

A research design refers to the overall plan or strategy that a researcher utilizes to answer a specific research question, hypothesis or investigate a particular phenomenon. It outlines the methods, techniques and procedures that will be employed to collect and analyze data so as to ensure that the study is valid and systematic. (Shadish; Cook & Campbel (2002). The Study will make use of the descriptive survey research design.

According to (Neuman, 2014) (Robson, 2011) research design is the blueprint that enables the researcher to logically and visually conduct the research project. While (Creswell. 2013) defines research design as a steps, a framework for the study that guides the collection and analysis of data. Also, a research design can also be seen as the overall strategy that connects the research question to the data needed to address them (Sekaran & Bougie 2016). There are numerous types of research designs which include surveys, experimental designs, quasi experimental designs, and descriptive, exploratory and explanatory designs.

A research design appropriate for a particular research problem, usually involves the consideration of the following factors according to (Creswell, 2014) (Kothari, 2004)

- The means of obtaining information and feasibility.
- Type of data involve whether qualitative, quantitative or mixed study.
- The availability and skills of the researcher that is the researcher's expertise.
- Generalizability of research finding.
- The objective of the problem to be studied.
- Ethical considerations of the research
- The nature of the problem to be studied.
- The availability of time and money for the research.

This study will use the cross-sectional research design which provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population. It includes cross-sectional and longitudinal studies using questionnaires for data

collection, with the intent of generalizing from a sample to a population (Babbie, 1990). A survey design provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population. From sample results, the researcher generalizes or makes claims about the population. in this study, the survey will be cross sectional that is data will be collected at one point and time. The survey research design was chosen because of its numerous advantages some of which are:

High Representativeness: Surveys provide a high level of general capability in representing a large population Due to the usual huge number of people who answers survey, the data being gathered possess a better description of the relative characteristics of the general population involved in the study. As compared to other methods of data gathering, surveys are able to extract data that are near to the exact attributes of the larger population.

It is an inexpensive method of carrying out research: Surveys are one of the most inexpensive methods of gathering quantitative data that is currently available. Some questionnaires can be self-administered, making it a possibility to avoid in-person interviews. That means you have access to a massive level of information from a large demographic in a relatively short time. You can place this option on your website, email it to individuals, or post it on social media profile.

Convenient Data Gathering: Surveys can be administered to the participants through a variety of ways. The questionnaires can simply be sent via e-mail or fax, or can be administered through the Internet. Nowadays, the online survey method has been the most popular way of gathering data from target participants. Aside from the convenience of data gathering, researchers are able to collect data from people around the globe.

Good Statistical Significance: Because of the high representativeness brought about by the survey method, it is often easier to find statistically significant results than other data gathering methods. Multiple variables can also be effectively analyzed using surveys.

Little or No Observer Subjectivity

Surveys are ideal for scientific research studies because they provide all the participants with a standardized stimulus. With such high reliability obtained, the researcher's own biases are eliminated.

Precise Results

As questions in the survey should undergo careful scrutiny and standardization, they provide uniform definitions to all the subjects who are to answer the questionnaires. Thus, there is a greater precision in terms of measuring the data gathered.

Area of study

The study will be carryout in Yaoundé 6 subdivision one of the subdivisions that make up mfoundi division. This subdivision was chosen considering the existence of about 30% of primary schools that make the center region in the division. The Center region equally comprise of a variety of schools beginning from nursery, primary. Secondary and right up to the university. Also, being the political capital of the country it harbors inhabitants from different backgrounds, ethnicity and religion. The region is divided in to 10 divisions with major ethnic groups such as the Ewondo, Bassa and the Vute. Also, the subdivision is accessible to the researcher and this favors easy collection of data as well as easy access to the different schools considering the location of the researcher. Also, the area was chosen considering the practicality of STEM education in the vicinity due to the presence of public schools it is certain that the curriculum is fully implemented following its specificity in STEM education. The calm atmosphere and stability of the region equally favors the easy collection of data for the study.

Figure 2: Map of Mfoundi Division

Population of study

Population of study refers to the entire group of individuals that the researcher seeks to study and draw conclusions about and generalize findings (Amambua, 2007). Also, population of study is a group of individuals, objects, items taken to measure a sample and possess the same

characteristics (Creswell, 2018). The study has a population of 120 participants of 4 public and 7 private primary schools in Yaoundé VI subdivision. The population will be examine in regard to target and accessible population as shown on the diagram below.

Figure 3: population of study

Target population

Target population refers to a specific subset or segment of the whole population that is the primary focus of the study (Willie, 2023). The total population of the study is 120 participants with a target population of 95 participants.

Accessible population.

Accessible population refers to the subset of individuals within the target population that are feasible and available to study that is it us the portion of the target population that the researcher can access and obtain data from. In this study, the accessible population is made up of 76 participants drawn from 10 primary schools in Yaoundé VI subdivision, 4 public schools and 6 private schools.

Sample and sampling technique

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample. Sample design is determined before data are collected. (Kothari, 1990). A good sample design must consider the following:

- Sample design must result in a truly representative sample.
- Sample design must be such which results in a small sampling error.
- Sample design must be viable in the context of funds available for the research study.

- Sample design must be such so that systematic bias can be controlled in a better way.
- Sample should be such that the results of the sample study can be applied, in general, for the universe with a reasonable level of confidence (Kothari, 1990)

A sample is a subset of a population that is selected to collect data on which conclusions will be drawn for the target population the sampling technique use in this study is the simple random sampling technique. This is a sampling technique whereby every individual of the population has an equal chance of being selected for participation in the study. To ensure that the sample is truly unbiased, the researcher will write the names of different schools on pieces of paper and shuffle in a basket after which the researcher will pick 10 schools with closed eyes.

Table 2: schools and samples.

school	population	sample
G.B.P.S Biyem-assi group 1A	12	10
G.B.P.S Biyem-assi group A2	12	10
G.B.P.S Biyem-assi group 2A1	12	06
G.B.P.S Biyem-assi group B2	12	10
Mario primary school	12	10
ALBISCOM nursery and primary	06	06
COSBIE primary school	12	10
semence de vie primary school	12	06
Andre Somers	06	03
ELGRA primary	06	05
total	95	76

Source: fieldwork 2024

Instruments for data collection.

To collect data, the researcher will use questionnaires made up of 26 closed ended questions. Questionnaires are advantageous in that:

- There is low cost even when the universe is large and is widely spread geographically Methods of Data Collection.
- It is free from the bias of the interviewer; answers are in respondents' own words.

- Respondents have adequate time to give well thought out answers
- Respondents, who are not easily approachable, can also be reached conveniently.
- Large samples can be made use of and thus the results can be made more dependable and reliable.

The questionnaires were constructed by the researcher under the supervision of her supervisor. There are basically two types of questionnaires, open ended questionnaires whereby the participants are required to supply the response to the item and close ended questionnaires whereby the participants are given alternative response to choose that which best suits them. In this study closed ended questions will be use. They are advantageous for the following reasons:

Quantifiable Data: Responses to close-ended questions can be easily quantified, making it simpler to analyze and interpret the data statistically.

Efficient Data Collection: Close-ended questionnaires are often quicker to complete, making them more efficient for large-scale surveys or when time is limited.

Reduced Ambiguity: The structured nature of close-ended questions reduces ambiguity, ensuring that respondents interpret the questions in a consistent manner.

Standardized Responses: Close-ended questions provide a set of predefined response options, which allows for standardized data collection and easy comparison of responses across participants.

Easier Analysis: Analyzing close-ended responses is generally more straightforward and less time-consuming than analyzing open-ended responses.

The questionnaire had 2 parts section A which deals with background information that is sector, gender, class, level and sex: section B on the other hand deals with the questions of the research variables both dependent and independent. Question 1=7 consisted of items for the first research question, 8-15 for the second research question and 16-21 for the third research question. The questions were adapted from the work of (Tallar, 2022). The dependent variable had 5 questions which made up item 22-26. There are made up of 4 likert scale items (A) Agree, (SA) strongly agree (D) Disagree and (SD) strongly disagree which will be tick by the respondents. The questions were constructed using indicators of the modalities of the research variables. The questionnaires will be self-administered by the researcher. The questionnaire is made up of two sections, Section A which consist of background information and Section B Which consist of items of the different research variables. There are a total of 70 questionnaires to be administered to 76 teachers of the selected primary schools in Yaoundé 6 subdivision. The questionnaire was chosen because it is easy to administer and equally responded and it is

relatively of low cost. Though the questionnaire has some disadvantages like missing questionnaires and some unanswered, the researcher will ensure that all questionnaires administered will be immediately collected and she will appeal to respondents to endeavor to answer all questions.

Table 3: likert scale items and weighting

OPTION	WEIGHT
Strongly disagree (SD)	1
Disagree (D)	2
Agree (A)	3
Strongly agree (SA)	4

Validity of the instrument

Validity is the extent to which an instrument measures what it is supposed to measure. In this study face and content validity will be measured.

Face validity

Face validity is about verifying if a test or questionnaire appears to measure what it is supposed to measure that is if a measure seems relevant and appropriate for what it is assessing on the surface (Bhandari, 2022).

To ensure face validity of the questionnaire, the researcher gave it to some peers and her supervisor to read and identify errors as well as give suggestions after which corrections were made and the questionnaire was then taken to the field for administration.

Content validity

Content validity is the degree to which an assessment instrument evaluates all aspects of the topic, construct or behavior that is designed to be measure. High content validity indicates the test fully covers the topic for the target audience. Lower results suggest that the test does not contain relevant facts of the subject matter. There are many ways to test for content validity which include pilot study, peer review and statistical methods (koller et al., 2017) (Creswell, J. W., & Miller, D. L. 2000). To test for content validity the researcher presented the instrument to senior students who approved it was valid and then to the supervisor who finally approved of its validity.

Reliability of the instrument

Reliability of the instrument is the degree to which the instrument consistently measured what it is expected to measure. In this research, the researcher used the test and retest reliability of questionnaire to two groups of respondents and collected them. The questionnaire was re administered to the same group of participants and the results were still the same. It showed that the instruments were reliable and can be used for the study. . The reliability coefficient was determined using the Cronbach Alpha formula.

The researcher administered the instrument to 20 participants drawn from Yaoundé VI subdivision and used the data collected to determine the cronbach alpha and the results were presented below;

Table 1 Reliability of the instrument

Items	Cronbach's alpha (N=20)	Number of items
project base learning	0.834	7
inquiry base learning	0.905	7
problem base learning	0.910	7
STEM skills	0.904	5
Total	**0.888**	**26**

Source: fieldwork 2024

Administration of the instrument

After the construction of the questionnaire, the researcher went to the field to administer the questionnaire after obtaining a research permit from the faculty sign by the dean. From school, the researcher met the head teachers of the different institutions to permit her to obtain some information from the staff. The researcher was briefed the staff on the research topic and how to answer the questions. The researcher pleaded with the staff to respond with honesty and sincerity as it is on the basis of their response that conclusions will be drawn. There were assured of confidentiality of any response given. Also, there was no indication of names of schools to ensure confidentiality of different teaching practices carryout in different schools.

Method of data analysis

The data will be analyze using descriptive statistics. Descriptive statistics are brief informational coefficients that summarize a given data set, which can be either a representation of the entire population or a sample of a population. Descriptive statistics are broken down

into measures of central tendency and measures of variability (spread). Measures of central tendency include the mean, while measures of variability include standard deviation, variance, minimum and maximum variables kurtosis and skewness (Adam H., 2024). Descriptive statistics help to give meaning to data thereby facilitating interpretation, verification of hypothesis and publication of results. The descriptive statistics will equally present the percentage and frequency of the data collected.

Furthermore, The Statistical Package for Social Science (SPSS) version 21 will be used for data analysis. The data was checked for accuracy and entered in to the SPSS software which is designed to analyze, display and transform data (Trochim & Donnely, 2007).

The research consisted of a questionnaire which were administered in the various schools that were in the sample made up of 4 likert scale items. Frequency distribution variables such as frequency tables were used to describe demographic variables such as gender.

Pearson's correlation, regression analysis and ANOVA (Analysis of Variance) will be used to test the effect of the independent variable on the dependent variable. This will enable the researcher to verify the three-research hypothesis.

Regression is necessary for the following reasons:
It examines relationships; Regression analysis can be used to explore the strength and nature of relationship between variables, which can complement the insight gained from the quantitative data.
It predicts models**:** it can help in building models that predict outcomes based on predictor variables, thus providing a quantitative validation for findings from qualitative data

It controls variables: Regression allows for controlling confounding variables, ensuring that the relationship observed is not spurious

Ethical considerations

In carrying out this research on the topic the influence of teaching methods on skill acquisition in stem education in some primary schools in Yaoundé 6 sub division", the following ethical considerations will be taken into consideration.

The researcher will use simple random sampling to draw select a sample for the study. This will help to curb all sought of bias and ensure transparency of test administration in the selected schools.

The student researcher will ensure that the items found on the questionnaire respect standard norms by checking its Validity, reliability, usability, balanced, comprehensive, fair, representative and objective.

To ensure that the questionnaire will be administered easily, the student researcher will collect a research permit from his department. Also, the researcher will ensure that confidentiality is maintained to the highest level.

Also, the researcher will pass through the administration of each school to seek the consent of teachers involve with which they will decide to participate voluntarily without any form of coercion

All the responses and information of participants will be kept confidential

CHAPTER FOUR

FINDINGS

This chapter presents data analysis, presentation and results of the findings. The data will be presented in the form of frequency tables, bar charts and histograms so as to give the data a clearer image. The predictor variables tested are project-based method, problem-based method and inquiry-based method which the modalities of the study. It looks at the effects of the modalities on the dependent variable which is the acquisition of skills in STEM education which is the dependent variable. Pearson's correlation was done to provide the degree of relationship between the predictor variable and the dependent variable. ANOVA was used to verify the degree of effect and linear regression to test the effect of the independent variable on the dependent variable.

The first section provides the analysis of the demographic data while the second section presents the descriptive and inferential statistics of the study's modalities.

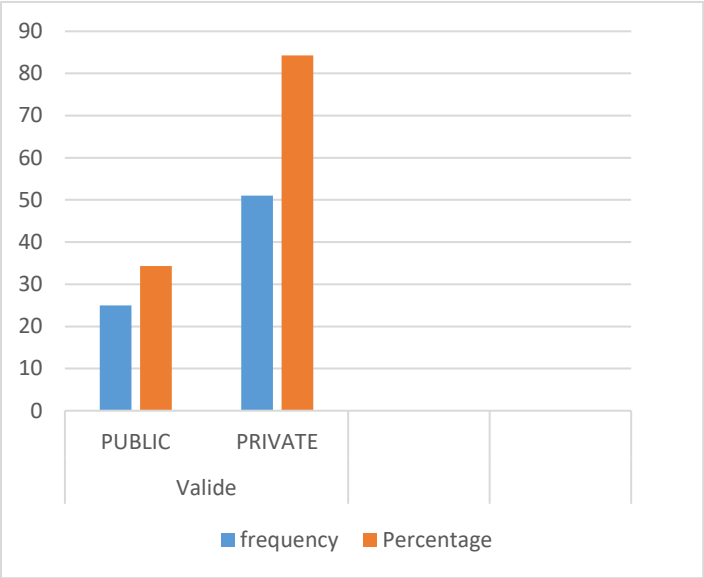
Table 5: frequency distribution based on sector

		frequency	Percentage
Valide	PUBLIC	25	34.3
	PRIVATE	51	84.3
	Total	76	100.0

Source: field work 2024

As shown in the table above, a total of 76 participants were randomly selected from public and private schools. A total of 25 participants (34.3%) were teachers from the public sector while a total of 51 participants were teachers from the private sector giving a percentage of 84.3%.

Figure 4: frequency and percentage distribution based on sector



Source: Field work 2024

From the figure above majority of the participants were from the private sector with a frequency and percentage of reason being that private school teachers 51 (84.3%) were willing to participate compared to public school teachers 25 (34.3%)

As shown in the table above, a total of 76 participants were randomly selected from public and private schools. A total of 30 participants (34.3%) were teachers from the public sector while a total of 51 participants were teachers from the private sector giving a percentage of 84.3%.

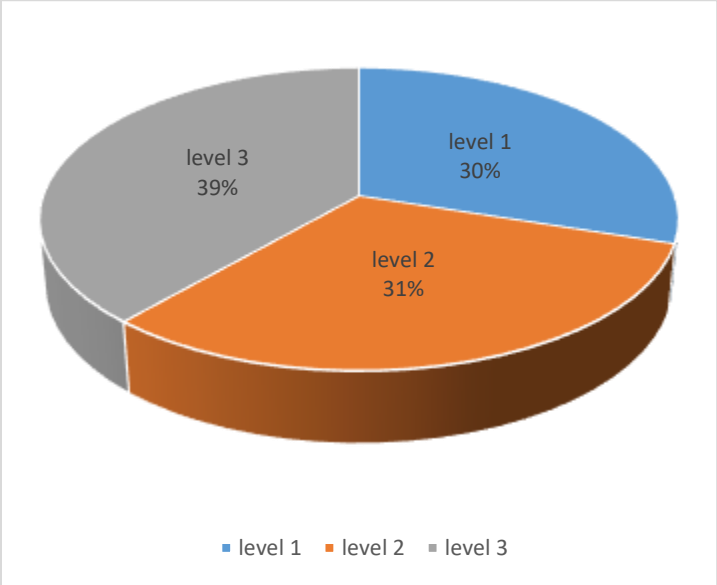
Table 6: frequency distribution based on level

		frequency	Percentage
Valide	level 1	27	35.5
	level 2	22	29.4
	level 3	27	35.5
	Total	76	100.0

Source: field work 2024

As shown on the table above out of the 76 participants randomly selected for the study 27 where teachers of level 1 with a percentage of 29.%, 22 participants were teachers of level 2 with a percentage of 35,5% while the majority were from level 3, a total of 27 participants with a percentage of 35.5%.

Figure 5: percentage distribution according to levels



From the figure above majority of participants were of level 3 with a percentage of 39%. Participants from level 2 had a percentage of 31 while level 1 had a lower percentage of 30.

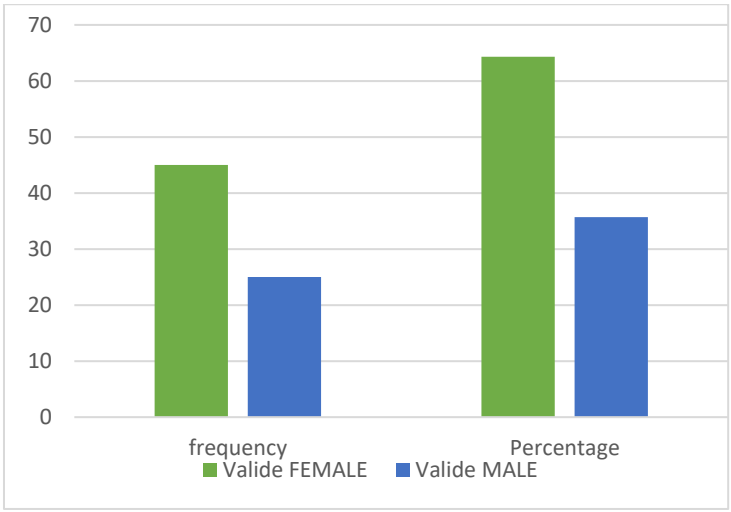
Table 7: frequency distribution based on gender

		frequency	Percentage
Valide	FEMALE	45	64.3
	MALE	31	35.7
	Total	76	100.0

Source: field work 2024

The table above presents the frequency distribution of the participants according to the gender. It is shown that majority of the participants in the study were female (50) which correspond to 64.3%. a total of 26 participants (35.7%) were male. The sample size was dominated by female participants for the fact that they expressed their ite willingness to participate in the study and make up the greatest percentage of teachers in the basic education sector.

Figure 6: frequency and percentage of gender representation

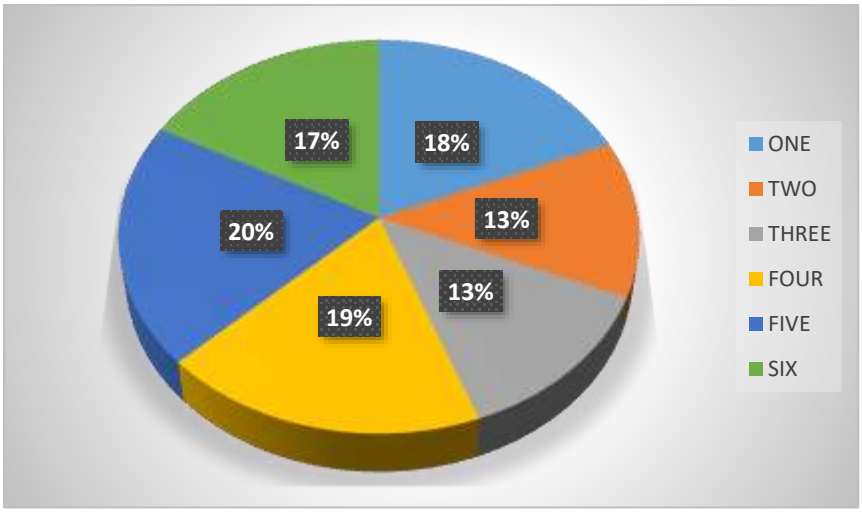


The bar charts above presents the frequency of males and females that participated in the study. 50 females participated with a frequency of 64.3%. a total of 26 males (35.7%) participated in the study.

Table 8: Presentation base on classes

Class	frequency	Percentage
ONE	13	18.6
TWO	9	12.9
THREE	15	12.9
FOUR	13	18.6
FIVE	14	20.0
SIX	12	17.1
Total	76	100.0

Figure 7: representation of percentage according to classes



The diagram above presents the percentages of respondents according to class. There were 19% respondents from class 4 of the total popukation,13% from class 2, 18% from class 4, 20% from class 5, 17% from class 6and 13% from class three.

Presentation of descriptive statistics on the main variables of the study

The objective of this section is to present the descriptive statistics on the independent and the dependent variables of the study. Here, descriptive statistics are presented on problem-based method, project-based method and inquiry-based method and skill acquisition in STEM education. This is presented in the following tables below.

Table 9: data presentation on project-based method item 1~7

No	Items	N	SA		A		D		SD		Mean (x)	Std. D
			f	%	*f*	%	*f*	%	*f*	%		
1	In STEM lessons, authentic problems are identified.	76	43	61.4	26	37.1	1	1.4	0	0	3.60	0.52
2	a project is identified to solve the problem	76	43	61.4	26	37.1	1	1.4	1	1.4	3.56	0.61
3	Projects carryout are related to real life situations.	76	46	65.7	26	37.1	2	2.9	0	0	3.63	0.54
4	Learners are wholly involve in the learning process.	76	35	50.0	31	44.3	3	4.3	1	1.4	3.43	1.65
5	Learners are group together to solve problems.	76	36	51.4	27	38.6	5	7.1	2	2.9	3.39	0.75
6	The teacher facilitates in the course of the project.	76	41	58.6	28	40.0	1	1.4	2	1	3.57	0.53
7	At the end of the project, A concrete artefact is produce to solve the problem identified.	76	34	48.6	30	42.9	4	5.7	2	2.9	3.37	0.73
N valid (listwise)		70									3.45	1.85

Source : Field work 2024

The table above presents the frequency distribution of the participant`s responses on the influence of project-based learning. A total of seven items were constructed to measure the effect of project-based learning on the acquisition of skills in STEM education in some primary schools in Yaoundé VI. In the first item, the researcher wanted to find out if authentic problems are identified in STEM lessons, a total of 69 participants strongly supported the view with a percentage of 98.5% that authentic problems are carried out during STEM lessons. In the second item, a total of 69(98.5%) participants strongly agreed that projects are carryout to solve problems. In item 3 a total of 69 participants with 98.5% strongly agreed that problem solving takes place during STEM lesson. In item 4, 56 participants with a corresponding percentage 84.3 % strongly agree that learners are active during STEM lessons. In item the fifth item 63(82%) participants strongly agreed that the teacher facilitates. In item 6, a total of 69 respondents were of the opinion that they facilitate learning during STEM lessons and the in last item 64(91.5%) participants strongly agree that new and concrete projects are produce during STEM lessons to solve daily life problems.

From the above statistics with a total mean of 3.4562 and standard deviation equal to .8543 we can conclude that majority of the participants shares the view that project-based learning has a significant effect on the acquisition of skills in STEM education.

Table 10: data presentation on inquiry-based method

No	Items	N	SA		A		D		SD		Mean (x)	Std. D
			F	*%*	*F*	*%*	*F*	*%*	*F*	*%*		
8	STEM lessons begin with open ended questions from the teacher.	76	12	17.1	14	20.0	30	42.9	14	20.0	2.34	0.99
9	Problems are identified by learners.	76	17	24.3	18	25.7	22	31.4	13	18.6	2.56	1.05
10	A fixed method usually the scientific method is use to find solutions to the problem.	76	10	14.3	15	21.4	27	38.6	18	25.7	2.24	0.99
11	Learners are group together to brainstorm, share ideas and propose solutions identify during STEM lessons.	76	17	24.3	25	35.7	17	24.3	11	15.7	2.69	1.06
12	The teacher supervises and provides help when difficulties are encountered.	76	28	40.0	22	31.4	13	18.6	7	10.0	3.01	0.99
13	STEM lessons end with discussion sessions where there's communication and reflection. .	76	19	27.1	14	20.0	19	27.1	18	25.7	2.48	1.15
14	A report is provided at the end of each inquiry session by each group.	76	13	18.6	18	25.7	14	20.0	25	35.7	2.27	1.10
N valid (listwise)		76										

Source : Field work 2024

The above tables presents the frequency, percentage, mean and standard deviation of the effect of inquiry based learning on the acquisition of skills in STEM education. A total of 7 items were used to calculate this. In the first item a total of 44(62.9%) disagreed that STEM lessons begin with open ended questions, in item the second item, 35 (64.3%) participants disagreed that they use a fixed method, in the fourth item 32(60%) participants agreed that they collaborate during STEM lessons, 50 with a corresponding 71.4% participants. In item 5 strongly agreed that the teacher facilitates. In the sixth item 19 participants strongly agreed and 19 disagreed with a percentage of 27.1% giving an average opinion with regards the fact that STEM lessons end with discussion and reflection sessions. In the last item 39 participants (55.7%) strongly disagreed with the view that they present reports at the end of inquiries.

From the above statistical interpretation it can be concluded that inquiry based approach influences skill acquisition in STEM education though not too significant.

Table 11: Data presentation on problem-based method

No	Items	N	SA		A		D		SD		Mean (x)	Std. d
			f	%	*f*	%	*f*	%	*f*	%		
15	Real world problems are identified during STEM lessons.	76	21	30.0	35	50.0	5	7.1	8	11.4	3.27	2.45
16	Learners brainstorm solutions and guided by the teacher.	76	33	47.1	25	35.7	7	10.0	5	7.1	3.23	1.90
17	Learners are group in different teams to solve the problem identified.	76	27	38.6	27	38.6	14	20.0	2	2.9	3.13	2.83
18	Learning is concrete and hands on,	76	23	32.9	27	38.6	13	18.6	7	10.0	2.94	2.96
19	Learners work in groups to communicate and share ideas.	76	28	40.0	29	41.4	10	14.3	3	4.3	3.17	3.83
20	The teacher guides and facilitates the different phases of solving the problem.	76	28	40.0	27	38.6	11	15.7	4	5.7	3.13	3.88
21	A prototype is produce at the end of the lesson to solve the problem identified.	76	17	23.9	30	42.9	21	30.0	2	2.9	3.16	2.53
N valid (listwise)		76										

Source : Field work 2024

The table above presents the descriptive statistics on the effect of problem-based learning on the acquisition of skills in STEM education. It consists of 7 items to measure this effect. From the statistics above, in item yhe first item 56(80.0%) agreed that STEM lessons begin with problem identification. In item the second item, 55 (82.8) participants strongly agreed that learners brainstorm solutions and think critically during STEM lessons, in item 3, 54 (77.2%) participants strongly agreed and 50(71.2%) participants were of the opinion that learners are group to solve problems. In the sixth item 55(78.6%) participants agreed that learning is concrete and 47(66.8) supported the fact that a prototype is produce at the end of STEM lessons.

Table 12: Data presentation on skills acquired in STEM education

No	Items	N	SA		A		D		SD		Mean (x)	Std. d
			f	%	*f*	%	*f*	%	*f*	%		
22	STEM lessons increase learners' to develop creative solutions	76	41	58.6	25	35.7	4	5.7	0	0	3.53	1.61
23	STEM lessons aid the generation of new and innovative ideas.	76	40	57.1	29	41.4	1	1.4	0	0	3.56	1.53
24	STEM lessons enable learners to think critically on how to solve problems.	76	42	60.0	25	35.7	3	4.3	0	0	3.56	0.58
25	During STEM lessons learners work effectively in a team and collaborate with each other.	76	38	54.3	25	35.7	5	7.1	2	2.9	3.40	1.75
26	Stem education enable learners to communicate both verbally and in writing.	76	31	44.3	31	44.3	6	8.6	2	2.9	3.30	0.78
N valid (listwise)		76										

Source : Field work 2024

From the table above 66 (58.6%) participants in item 1 strongly agreed that STEM lessons enable them to develop creative solutions, 69 participants in item 2 strongly agreed that STEM lessons enable learners to be innovative with a corresponding of 98.5%, 42 (60.0%) participants in item 3, 77 participants with 95.7% strongly agreed that STEM lessons enable learners to think critically, 63 (90%) participants in item 4 strongly agreed that stem lessons enable learners to collaborate and 62(88.6%) participants strongly agreed that STEM lessons enable learners to communicate verbally and in writing in item 5.

With the above statistics we can conclude that teaching methods foster the acquisition of skills in STEM education. That is, there's a significant relationship.

Inferential statistics of the study

The present section focuses on the verification of research hypotheses of the study. To do this, the simple linear regression analysis was used to determine the effect of teaching methods on the acquisition of skills in STEM education in some primary schools in Yaoundé VI subdivision. To test the research hypotheses of the study, it is important to state the alternative and null hypothesis of the study

Table 13: correlation of variables

Corrélations

	Project base	Inquiry base	problem base	STEM Skills
Project b		-.038	.032	.230*
Inquiry	-.038			
Problem	.032	.367**		
	.230*	.265*	.549**	
SS				

Correlation is significant at 0.05 (2-tailed).

From the table above when project-based learning is crossed with STEM skills, it gives a correlation coefficient of r=.230 at p-value 0.001 indicating a strong positive relationship between the two variables. When inquiry base learning is crossed with STEM skills it gives a correlation coefficient of r= .265 at p-value 0,027 indicating a strong relationship that is it is significant. When problem-based learning is crossed with STEM skills it gives a coefficient of r= 0.549 at p-value 0.000 which is significant.

Hence, from the correlation analysis, it can be concluded that all three measured IVs are positively correlated and DV is statistically significant. Moreover, due to the confirmed

linearity of relationships between the separate IVs and the DV, the precondition to run regression analyses to actually test the previously developed hypotheses is met (Saunders et al, 2016)

Verification of hypothesis

Verification of hypothesis one

To measure the effect of Project-based method on skill acquisition of STEM education in Yaoundé VI subdivision it is necessary to sight the hypotheses of this modality

H1: Project base method has an influence on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

H01: Project base method has no effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

Table 14: Model Summary of the effect of project-based method on skill acquisition in STEM education

Model	R	R-square	Adjusted R-square	Estimation of standard error
1	0.57	0.32	.039	.39503

a. predictor variable: (constant), PJBL

b. dependent Variable: SS

From the table above, the R-square of 0.57 indicates a moderately strong positive linear relationship between the independent variable project-based method and the dependent variable skill acquisition in STEM education. This implies that as the independent variable increases the dependent variable increases at a moderate rate. The r-squared value of 0.32 explains a 32% variation in the dependent variable. The standard error of 0.39503 explains how the observe values vary from the predicted value thus a moderately low amount of error

Table 15: ANOVA of the effects of project-based learning on skill acquisition in STEM education

Model		Sum of squares	Df	Mean of squares	F	Sig.
1	Regression	1.592	1	1592	10.791	.000
	Residual	10.611	68	.156		
	Total	11.203	69			

a. dependent variable: SS

b. predictor value: (constant), PJBL

From the table above, the analysis of variance was used to measure the effect of project based learning (independent variable) on the acquisition of skills in STEM education (dependent

variable).the F test of 10.791 indicates the regression model has a very high statistical significance. The statistics has a p value of 0.000 which implies that the regression model is highly significant. This implies that the independent variable highly influences the dependent variable thus completely rejecting the null hypothesis which states that project base learning has no effect on the acquisition of skills in STEM education.

Table 16: Coefficients of the effect of project-based learning on skill acquisition in STEM education.

Model		Non standardise coefficient		Standardise coefficient	t	Sig.
		A	Standard error	Bêta		
1	(Constant)	10.569	.466		25.513	.000
	PjBL	.257	.132	.230	1.947	.000

a. dépendent variable : SS

The table above shows the regression analysis. The independent variable project-based method was regressed on the dependent variable acquisition of skills in STEM education.

It had a significant level of 0.000 with a t-value of 25.513 which implies that. The slope coefficient of .230 corresponding 10.569 implies there's a positive correlation. Taking in to consideration all this implies that there's a significant effect of project-based learning on skill acquisition in STEM education.

Verification of hypothesis two

To measure the effect of inquiry-based method on skill acquisition of STEM education in Yaoundé VI subdivision it is necessary to sight the hypotheses of this modality

Ha2: Inquiry base learning has an effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

H02: Inquiry base learning has no effect on skill acquisition in STEM education in primary schools in Yaoundé VI subdivision.

Table 17: model summary on the effect of inquiry-based learning on skill acquisition in STEM education.

Model	R	R-square	Adjusted R-square	Estimate of standard error
1	.265[a]	.070	.056	.39142

a. predictor : (constant), IBL

b. dependent variable : SS

The table above presents the model summary of the effect of inquiry-based learning on the acquisition of skills in teaching methods. From the statistics, there's an r value of 0.265 suggest

a relatively weak positive correlation. Therefore, there's a weak linear relationship between the predictor variable and the dependent variable. The r-squared coefficient of 0.70 explains that only 7% in the outcome variable is explained by the predictor variable. The adjusted r-square of 0.56 implies that inquiry base learning might not strongly the acquisition of skills in STEM education. The low standard error explains a better fit of the data.

Table 18: ANOVA of the effect of inquiry-based learning on skill acquisition in STEM education

Model		Sum of squares	Df	Sum of means	F	Sig.
1	Regression	.784	1	.784	5.120	.027[b]
	Residual	10.418	68	.153		
	Total	11.203	69			

b. predictor: (constant), IBL

The table above presents the effect of inquiry-based learning on the acquisition of skills in STEM education. The f test of 5.120

The p value of 0.027 indicates that the regression model is statistically significant at a 95% confidence level which implies that the observed relationship between the independent and dependent variable occurred by random chance. We can conclude that the inquiry base method has an effect on skill acquisition in STEM education though not too significant thereby rejecting the null hypothesis.

Table 19: Coefficients of the effect of inquiry-based learning on skill acquisition in STEM education

Model		Non standardise coefficient		Standardise coefficient	T	Sig.
		A	Standard error	Bêta		
1	(Constante)	3.108	.167		18.584	.000
	IBL	.145	.064	.265	2.263	.000

a. Variable dépendante : SS

The table above shows the regression analysis. The independent variable inquiry-based learning was regressed on the dependent variable acquisition of skills in STEM education.

It had a significant level of 0.000 with a t-value of 18.584 which implies that. The slope coefficient of .145 corresponding to 3.108. This implies that a unit increase in the use of inquiry-based learning will increase by 0.145 increase in the skills acquired in STEM education.

Conclusively. From the above interpretation inquiry-based learning has a significant effect on the acquisition of skills in STEM education,

Verification of hypothesis three

To measure the effect of inquiry-based learning on skill acquisition of STEM education in Yaoundé VI subdivision it is necessary to sight the hypotheses of this modality

Ha3: Problem base learning has an effect on skill acquisition in STEM education in primary schools in Yaoundé 6 subdivision.

H03: problem-based learning has no effect on skill acquisition in STEM education in primary schools in Yaoundé 6 subdivision.

Table 20: model summary of the effects of problem-based learning on skill acquisition in STEM education

Modèle	R	R-square	Adjusted R Square	Estimation of standard error
1	.149[a]	.022	.008	.40133

a. predictor values: (constant), PBL
b. dependent variable: SS

The table above presents the model summary of the effect of inquiry-based learning on the acquisition of skills in teaching methods. From the statistics, there's an r value of 0.149 suggest a relatively weak positive correlation. Therefore, there's a weak linear relationship between the predictor variable and the dependent variable. The r-squared coefficient of 0.22 explains that only 2% in the outcome variable is explained by the predictor variable. The adjusted r-square of 0.008 implies that project base learning might not strongly influence the acquisition of skills in STEM education. The low standard error explains a better fit of the data.

Table 21: ANOVA of the effect of problem-based learning on the acquisition of skills in STEM education

Model		Sum of squares	Df	Mean of square	F	Sig.
1	Regression	.250	1	.250	1.553	.217[b]
	Residual	10.953	68	.161		
	Total	11.203	69			

a. dependent variable : SS
c. Valeurs prédites : (constantes), PBL

The table above presents the effect of inquiry-based learning on the acquisition of skills in STEM education. The f test of was used to verify the degree of influence of problem-based learning on skill acquisition in STEM education. The linear regression F test has the alternative research hypothesis that problem-based learning has a statistically significant influence on skill acquisition in STEM education. Which can equally be represented as $R^2 = 0$, F (1,553) = 11.203, p = .000

The p value of 0.217 indicates that the regression model is statistically significant at a 95% confidence level which implies that the observed relationship between the independent and dependent variable occurred by random chance. We can conclude that the problem base learning has an effect on skill acquisition in STEM education though not too significant thereby rejecting the null hypothesis.

Table 22: Coefficients of the effect of problem-based learning on skill acquisition in STEM education

Model		Non standardise coefficients		standardise coefficients	T	Sig.
		A	Standard error	Bêta		
1	(Constant)	3.197	.226		14.168	.000
	PBL	.087	.070	.149	1.246	.000

a. dependent variable : SS

The table above shows the regression analysis. The independent variable inquiry-based learning was regressed on the dependent variable acquisition of skills in STEM education.
It had a significant level of 0.000 with a t-value of 14 which implies that. The slope coefficient of .145 corresponding to 3.197 this implies that a unit increase in the use of problem-based learning will increase by 0.087 increase in the skills acquired in STEM education.

From the above interpretation we can conclude that problem-based learning has a significant effect on the acquisition of skills in STEM education,

CHAPTER FIVE
SUMMARY OF FINDINGS

This chapter presents the interpretation of results gotten from the data analysis of the previous chapter. The goal of this chapter is to interpret the findings and draw logical conclusion of the study and ascertain its contributions. The chapter focuses on the discussion of the findings summary, conclusion, recommendations, suggestions for further research and limitations of the study

Discussion of findings

This study was had its main objective which was to determine the effectiveness of teaching methods on the acquisition of skills in STEM education. The teaching methods that serve as the main modalities of the study (independent variables) are project-based learning, problem-based learning and inquiry-based learning. The major STEM skills that is the dependent variable which the study looked at are communication, creativity, critical thinking, collaboration (4Cs) and problem solving. The results will be based on the findings of the study and empirical review from academic scholars who have equally carried out similar studies on teaching methods and skill acquisition in STEM education.

Project base learning and skill acquisition in STEM education

From the findings, project-based learning has a significant effect on the acquisition of skills in STEM education in some primary schools in Yaoundé VI subdivision. This is explain by the fact that majority of the participants strongly agreed that project based learning fostered skill acquisition in STEM education that is 90% of the respondents. This is equally visible in the aspects of project-based learning. In project-based learning, students work in groups which promotes collaboration and active construction of knowledge, real life problems are identified which fosters critical thinking on how to solve the problem and at the end a project is identified and implemented which develops the creativity of learners. This findings corrobate to the work of (Shepherd 1998) who in a study examining Grades 4 and 5 students working on a nine-week project to define and find solutions related to science, Shepherd (1998) found that the project-learning students scored significantly higher on a critical thinking test in comparison to a control group who did not take part in the inquiry project. The project-learning students also demonstrated greater confidence in their learning.

These findings imply that project based learning fosters the acquisition of skills in STEM education therefore educators should provide necessary resources to foster the acquisition of

these skills through project based learning. In a similar study by (Setyowati et al. 2020) the topic of STEM PjBL became a topic for instructional content as a method of increasing students' critical thinking and awareness in a lengthy period and sustainability. Based on the feasibility test results, a score of 85 with a very strong grounding for the critical thinking ability test and a score of 97 with a strong background for problem solving and creativity
Also, the strong significance is equally explained by the fact that project-based learning is one of the major methods that are recommended in the Cameroon basic education curriculum for the implementation of STEM education thus its implementation in major primary schools.

Inquiry based learning and Skill Acquisition in STEM Education

The findings from the study shows that inquiry-based learning has a significant effect on the acquisition of skills in STEM education. THIS implies that the use of inquiry base method fosters the acquisition of critical thinking, creativity, problem solving and collaboration. This findings corrobate to the work of (Eja et al. 2020), 25% of students' critical thinking abilities were in the low category, 34% of students' critical thinking and creative abilities were in the medium category, and 41% of students' critical thinking abilities were in the high category. Peer assessment backs up this result, which shows 12% in the low category, 41% in the medium category, and 47% in the high category. It laso corroborate to the work of Newmann et al. (1996) conducted a large study evaluating elementary, middle, and high schools that had implemented authentic pedagogy and authentic academic performance approaches in their mathematics and social studies classrooms. They sought to determine to what extent student achievement improved in schools with high levels of authentic pedagogy involving higher-order thinking, deep-knowledge approaches, and connections to the world beyond the classroom. The research team observed 504 lessons, analyzed 234 assessment tasks, and systematically sampled student work. The researchers found that environments with high levels of authentic pedagogy led to higher academic achievement among all students. As a result, the study's conclusion is that students' critical thinking processes during IBL learning produce excellent results.

Educators are encourage to use a variety of these learner method of teaching to ensure the development of relevant skills in STEM education and ensure smooth integration of learners in the 21st century. Also, this method fosters collaboration as learners work in groups and it equally enables learners to communicate both verbally and in writing as reports are presented at the end of inquiries though it is not the case of some primary schools in Yaoundé VI subdivision. Also, inquiry-based learning fosters critical thinking as learners think to develop solutions during

inquiry and when responding to open ended questions. Also the use of open ended questions probs and develops critical thinking.

Problem Based learning and Skill Acquisition in STEM Education

The results present that problem-based learning foster the acquisition of skills in STEM education in Yaoundé VI subdivision. This findings corrobate to the findings of (Isro et al., 2021) which revealed that students could demonstrate diversity in their critical thinking skills. All aspects of all strategies and tactics fall into this category. The top category includes explanations of basic aspects, basic support, and conclusions. The first step is to define the type of intermediary. The critical thinking and collaborative abilities in relation to STEM disciplines PBL has a relatively high average. Also, Atheson (2004) had a study comparing three teaching methods: hands on learning, blended learning and problem-based learning on recall of facts, understanding of concepts and acquisition of critical thinking and problem solving in elementary STEM classroom. The author concluded there was a significant difference in students' performance in health science using the three methods as measured by the examination score. As indicated from this study the students mean score for understanding and recalling were higher in problem-based learning than in hands on minds on and blended learning.

This effect is explain by the fact that problem based learning involves group work and active learning which develops the skill of collaboration and communication, production of a prototype which develops learners creative and critical thinking skills. However, this low percentage is as a result of the fact that this teaching method is not carried out in most primary schools in Yaoundé VI subdivision.

Summary of discussion

From the summary of the findingsother principal finding is in regard to creating an authentic, safe classroom environment. The participants suggested that creating a positive, authentic learning environment should be a priority for teachers when working towards skill acquisition in STEM education. The classroom environment involves providing students space where they are comfortable with asking questions, making mistakes, and providing feedback to their teachers. Additionally, within these environments students can develop meaningful and memorable experiences, and then they can associate those experiences with STEM subjects. Lastly, the classroom environment should be authentic, where concepts relate to real-world

situations, and topics are relevant to students' interests. The existing literature agrees with these findings, suggesting that students enjoy the experience of participating in authentic projects, and these authentic experiences can impact student career aspirations and interest in STEM subjects (Beier et al., 2019). This view is equally supported by (LaForce et al., 2017)

From the study, it can be seen that project-based learning has a stronger effect on the acquisition ok skills in STEM education. This view is similar to that of scholars such as (Capraro & Slough, 2013). (Boaler. 1997) and (Tallar G.2022) who said active methods especially project-based learning, fostered the acquisition of skills in STEM education.

Also, studies have equally proven that problem-based learning plays an important role in the acquisition of skills in STEM education. But however as a result of its poor implementation and its inapplication in some schools accounts for the low effect it has on skill acquisition in STEM education. From review of literature it proves that problem-based learning when properly implemented fosters the development of critical thinking, creativity, collaboration, communication and problem solving which are end products of appropriate teaching STEM education as suggested by (Tallar G.2022)

Suggestions

Base on the findings of the study, it has proven that teaching methods have an effect on the acquisition of skills in STEM education so the researcher recommends the following

The government through members of the pedagogic chain should organize capacity building seminars to equip teachers of the Basic education sector with competences and skills. This will enable the teachers who are the guarantors of quality education to properly implement STEM education. Proper implementation will enable learners to acquire skills that will enable them to fully integrate in the 21st century and equally a suitable workforce that will drive the country to emergence by the year 2035.

Curriculum developers should properly draft the curriculum with clear and explicit sections on STEM education with emphasis on suitable teaching methods. Also, policy makers should make available financial resources to ensure acquisition of material resources to enhance STEM education.

Teachers should create learner centered environments, implement research-based instructional strategies that is current instructional strategies that have proven to be effective in increasing student interest in STEM subjects. These strategies follow a social constructivist view on

learning, which states that students learn best through social and cultural interactions and when they are actively engaged in the learning process.

Teachers should allow learners to ask and answer questions, explore and make mistakes. Teachers create classroom climate, provides suggestions regarding creating an environment that promotes learning and engagement. The classroom climate should be one that is safe, promotes a growth mindset, allows for open communication between students and teachers, and is student-centered. They should equally create authentic learning environments that makes learning meaningful.

To better capitalize on the benefits of this teaching methods, assessments should be align to skill buildings so as to measure higher order skills that this methods are design to cultivate such as critical thinking, creativity, problem solving and team work. Institutions should modify their assessment practice accordingly.

Institutions should foster cross disciplinarily and collaboration. The study underscores the value of authentic real-world experiences for STEM skill development. Institutions should encourage greater collaboration between STEM departments and industries as well as educational partners to create opportunities for problem-based learning and project-based learning.

Institutions should longitudinally track students' outcomes. This will enable teachers and researchers to fully understand the impact of interactive and student-centered teaching methods so as to effectively compare their impact with traditional teaching methods.

The suggestions of this study will be proposed on three headings, suggestions for policy, practice and further research.

In regards to policy, curriculum developers should emphasize the use of active methods of teaching like the project base, inquiry base and problem base to foster the acquisition of skills in STEM education. Also, the government should equally organize seminars and pedagogic animation sessions to train teachers on the effective applications of these teaching methodologies in order to achieve optimum results.

In the domain of practice, teachers who are the curriculum implementers and the guarantors of quality education should use learner centered teaching methods that is problem base, project base and inquiry base methods. This will enable learners to be at the center of the teaching learning process and facilitate the acquisition of skills in STEM education so that learners can effectively integrate and meet the demands of the 21st century.

Suggestion for further study

For further research, a similar study could be carried out on the influence of teaching methods on the acquisition of skills in STEM education in primary schools in Mfoundi division. This will permit the researcher to use a larger sample size, since the greater the sample size the better the results obtained.

Limitations of study

This study was carried out in 10 primary schools in Yaoundé VI subdivision using three teaching methods which are; project base method, problem base method and inquiry base method.

Conclusion

This chapter presents a conclusion to the study the influence of teaching methods on the acquisition of skills in some primary schools in Yaoundé VI subdivision. The study compared 3 teaching methods, project-based learning, problem-based learning and inquiry-based learning on STEM skills; critical thinking, creativity, collaboration and problem solving. The results indicate that project-based learning with 90% is applied in the selected primary schools and majorly fostered the acquisition of skills in STEM education. Though inquiry-based learning and project based had a percentage of 50%, it is obvious that this teaching methods isn't applied in most of the selected schools thus fostered poor skill acquisition. Thus it is obvious that learner centered teaching strategies are best for the implementation of STEM education to better foster skill acquisition.

REFERENCES

Aksela, M., & Haatainen, O. (2019). Project-based learning (PBL) in practice: Active Teachers' Views of Its Advantages and Challenges. In Integrated Education for the Real World: 5th International STEM in Education Conference Post Conference Proceedings (pp. 9–16). Queensland University of Technology.

Anette M., Maija A., (2022). The key characteristics of project-based learning: how teachers implement projects in K-12 science education. *Journal of Disciplinary and Interdisciplinary Science Education Research* **vol 4(2)** https://doi.org/10.1186/s43031-021-00042-x

Aslam, S.; Alghamdi, A.A.; Abid, N.; Kumar, T.(2015). Challenges in Implementing STEM Education: Insights from Novice STEM Teachers in Developing Countries. Sustainability 2023, 15, 14455. https://doi.org/10.3390/su151914455

Barron, B., & Darling-Hammond, L. (2008). Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. Powerful Learning: What We Know About Teaching for Understanding (pp. 11-70). San Francisco, CA: Jossey-Bass.

Barron, B., Schwartz, D., Vye, N., Moore, A., Petrosino, A., Zech, L., Bransford, J., & The Cognition and Technology Group at Vanderbilt. (1998). Doing with understanding: Lessons from research on problem- and project-based learning. The Journal of the Learning Sciences, 7, 271-311.

Barrow, L. (2006). A brief history of inquiry-From Dewey to Standards. Journal of Science Teacher Education, 17, 265-78. Barrows, H. (1992). The tutorial process. Springfield, IL: Southern Illinois University School of Medicine.

Barrows, H. (1996). Problem-based learning in medicine and beyond: A brief overview. In L. Wilkerson & H. Gilselaers (eds.), bringing problem-based learning to higher education: Theory and practice. San Franscisco, CA: Jossey-Bass Inc

Beier M., Michelle H., Saterbak A. (2018). The effect of authentic project based learning on attitudes and career aspirations in STEM. *Journal of research (56)2 10.1002/tea.21465.*

Brooks, J., & Brooks, M. (1993). In search of understanding: the case for constructivist classrooms, ASCD. *NDT Resource Center database*.

Brunner, J.S.(1966). Towards a theory of instruction. Cambridge,MA: Havard university press,

Burke l., Macneil b.j., (2011). Educate to innovate, how the Obama plan for STEM education fall short. Journal on education, engineering and environmental science.

Bybee, R.W. the Case for STEM Education Challenges and Opportunities; National STEM Teachers Association: Washington, DC, USA, 2013.

Carter, Kendal C., "STEM Education in the Elementary School Classroom" (2020). Master of Science in Education | Master's Theses. 21. https://doi.org/10.33015/dominican.edu/2020.EDU.11

Çeviki K. M., Büşra B. K. The Effect of STEM Education Integrated into Teaching-Learning Approaches (SEITLA) on Learning Outcomes: A Meta-Analysis Study Mustafa University. *International Journal of Progressive Education, Volume 18 Number 2*.

Corbin, J. & Strauss, A. (2008). Basics of qualitative research: Techniques and procedures for developing grounded theory. Thousand Oaks, CA: Sage.

Creswell, J. W. (2013). Research design: qualitative, quantitative, and mixed methods approaches. London, UK: Sage.

Creswell, J. W. (2014). Qualitative inquiry & research design: Choosing among five approaches (4th ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. Theory into Practice, 39, 124-130. doi:10.1207/s15430421tip3903

Darling-Hammond, L. (2008). Introduction: Teaching and learning for understanding. Powerful Learning: What We Know About Teaching for Understanding (pp. 1- 9). San Francisco, CA: Jossey-Bass.

David S. Sharon F.(2013) Inquiry based learning, a review of research literature.

Dewey J.(1938). Experience and education. Macmillan

Dewey, J. (1938) *Experience and Education*. New York: Collier Books.

Driscoll, M. (2000). *Psychology of Learning for Instruction*. Boston: Allyn& Bacon

Elliott, S.N., Kratochwill, T.R., Littlefield Cook, J. & Travers, J. (2000). *Educational psychology: Effective teaching, effective learning (3rd ed.)*. Boston, MA: McGraw-Hill College.

Gholan, A. (2019). Inquiry-Based Learning: Student Teachers' Challenges and Perceptions. Journal of Inquiry & Action in Education, 10(2)

Gradini E.,Cut K.,Noviani J.,(2022). Development of higher order thinking skills test on mathematics in secondary *school Aksioma journal program vol11 (1*) .

Guoxing, Y. (2004). Perception, practice, and progress: Significance of scaffolding and zone of proximal development for second or foreign language teachers. Asian EFL Journal, 6(4),

Hattie, J. (2009). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. New York: Routledge.

Heather, B. randy B. (2008). The many levels of inquiry

Hmelo, C. E. (1998). Problem-based learning: Effects on the early acquisition of cognitive skill in medicine. Journal of the Learning Sciences, 7(2), 173–208. https://doi.org/10.1207/s15327809jls0702_2

Hom, E. J. (2014, February 11). What is STEM Education? Live Science

Johnson, A. (2017). I Made My Classroom Look Like the Real World and Test Scores Soared. Ted ED.

Johnson, G. (2019, May 8). Preparing Our Youth for a Rapidly Changing Digital World. U.S. News and World Report.

Laforce M., Elizabeth N., Courtney K., (2017) Problem-Based Learning (PBL) and Student Interest in STEM Careers: The Roles of Motivation and Ability Beliefs. Educational sciences 7(4):92 DOI: 10.3390/Edusci7040092.

Learning Approaches (SEITLA) on Learning Outcomes: A Meta-Analysis Study. *International Journal of Progressive Education,* Volume 18 Number 2, 2022 © 2022 INASED DOI: 10.29329/ijpe.2022.431.

Leung, W.M.V. (2023). STEM Education in Early Years: Challenges and Opportunities in Changing Teachers' Pedagogical Strategies. Educ. Sci. VOL 13, 490. https://doi.org/10.3390/ educsci13050490.

María J. Serrano J.R. (2020). Interest in STEM disciplines and teaching methodologies. Perception of secondary school students and pre service teacher Educar 2020, vol. 56/2 369-386 https://doi.org/10.5565/rev/educar.1065

Marick Group. (2016). A Look At The History Of STEM (And Why We Love It). Marick Group.

MINEDUB (2018) Cameroon primary school curriculum for the English subsystem.

Moore, T.; Stohlmann, M.; Wang, H.; Tank, K.; Glancy, A.; Roehrig, G. Implementation and integration of engineering in K-12 STEM education. In Engineering in Pre-College Settings: Synthesizing Research, Policy, and Practices.

Mustafa Ç., Büşra B., (2022) the Effect of STEM Education Integrated into Teaching-

Noriah I., Suhaidi E. (2006) inquiry based learning: a new approach to classroom learning. *English Language Journal (2006) Vol.2 (1): 13-24. UPSI Malaysia 13*

Olivia G., Saul. M, (2024) Constructivism Learning Theory & Philosophy Of Education

Patricia N., Madeline C., (2020) the Impact of Project-Based Learning on Student Content Knowledge in an Undergraduate, Teacher Preparation, Journal *for Leadership and Instruction.*

Pedaste M., Siswa A. Eleftheria T., Ellen T. Kamp b , Constantinos C. , Zacharias C. Leo A. (2015). Phases of inquiry-based learning: Definitions and the inquiry.

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., … Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. Educational Research Review, 14, 47–61. https://doi.org/10.1016/ j.edurev.2015.02.003. Sadler, T. D. (2009).

Piaget J. (1969). The psychology of the child. Basic books.

Qureshi, A., & Qureshi, N. (2021). Challenges and issues of STEM education. Adv Mobile Learn Educ Res, 2021, 1(2), 146-161. https://doi.org/10.25082/AMLER.2021.02.009

Rachad Z., Yousof A., Barida H., (2012). Students' interest in STEM education. A survey from the UAE DOI: 10.1109/EDUCON.2012.6201144

Rea L., Marina T., Yehudit J. (2021). Perceptions of STEM alumni and students on developing 21st century skills through methods of teaching and learning. *Journal on studies in Educational Evaluation*

Rina D., Ummy S., Ukima N., (…) (2019) Improving Mathematical Critical Thinking Skill through STEM-PjBL: A Systematic Literature Review International Journal of Research in STEM Education (IJRSE), Vol. 4 (2).

Sanders, M. (2009). STEM, STEM Education, STEM Mania. Technology Teacher, 68, 20-26. **CreativeEducation**,Vol.11No.4.https://doi.org/10.17763/haer.57.1.j463w79r56455411

Sanders, M. E., (2012). Integrative STEM education as best practice. Explorations of best practice in technology, design, and engineering education (Vol.2, pp.103-117). Queensland, AUS: Griffith Institute for Educational Research

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. Harvard Educational Review, 57(1), 1-22. Retrieved from Eric database EJ351846.

Susanti D., (2020) Analysis of elementary school teachers' perspectives on STEM implementation journal of elementary education vol18, no 1. Doi:10.21831/jpe.v8i1.31262

Syazwani M,, Nurul A., P., Cheong T.(2020). Integration factors Affecting Effective Instructional Practices in Teaching Mathematics Asian Journal of University Education (AJUE) Volume 16, Number 1.

Talar G. (2020) *Best teaching practices to increase student interest in STEM subjects.* Pepperedine digital commons.

Tambo (2012) principles and methods of teaching: application in Cameroon schools. ANUCAM publisher

Thomas, J. W. (2000). A review of research on project-based learning. Retrieved from http://www.bobpearlman.org/BestPractices/PBL_Research.pdf

Thomas, J. W. (2000). A review of research on project-based learning. San Rafael, CA: Autodesk Foundation

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Vygotsky, L.S. (1962) Thought and Language, Cambridge, MA: MIT Press.

Yelland H., (2019) creating cotemporary STEM learning ecologies to support transition. Early childhood Australia national conference.

Yelland, N. A pedagogy of multiliteracies: Young children and multimodal learning with tablets. Br. J. Educ. Technol. 2018, 49, 847–858.

Yildrim B., Sidekli S.,(2018) STEM applications in mathematics education on different dependent variables. *Journal of Baltic sciences vol (17) 2.*

APPENDIXES

Appendix 1: Research authorization

REPUBLIQUE DU CAMEROUN
Paix – Travail – Patrie
*****
UNIVERSITE DE YAOUNDE I
*****
FACULTE DES SCIENCES DE L'EDUCATION
*****
DEPARTEMENT DE CURRICULA ET EVALUATION

REPUBLIC OF CAMEROON
Peace – Work – Fatherland
*****
THE UNIVERSITY OF YAOUNDE I
*****
THE FACULTY OF EDUCATION
*****
DEPARTMENT OF CURRICULUM AND EVALUATION

The Dean

N° 017 /24/UYI/FSE/CD

AUTORISATION FOR RESEARCH

I the undersigned, **Professor BELA Cyrille Bienvenu,** Dean of the Faculty of Education of the University of Yaoundé I, hereby certify that **ANONDA Larissa NYOH,** Matricule **22V3820**, is a student in Masters II in the Faculty of Education, Department: ***CURRICULUM AND EVALUATION***, Specialty: ***CURRICULUM DEVELOPMENT AND EVALUATION.***

The concerned is carrying out a research work in view of preparing a Master's Degree, under the supervision of **Dr. SHAÏBOU Abdoulaï HAJI.** Her work is titled: ***« The Effectiveness of Teaching Methods in Acquiring Skills in STEM Education in Some Selected Primary Schools in Yaounde 6 Subdivision ».***

I will be very grateful if you provide her all the information that can be helpful in the realization of her research work.

This Authorization is to serve the concerned for whatever purpose it is intented for.

Done in Yaoundé, le 20 JAN 2024

For the dean

UNIVERSITE DE YAOUNDE I THE UNIVERSITY OF YAOUNDE I FACULTE DES SCIENCES DE L'EDUCATION OF EDUCATION
Le Vice-Doyen

BELA Etienne
Professeur

Appendix 2 : Questionnaire

REPUBLIQUE DU CAMEROUN
Paix – Travail – Patrie
*****
UNIVERSITE DE YAOUNDE I
*****
FACULTE DES SCIENCES DE L'EDUCATION
*****
DEPARTEMENT DE CURRICULA ET EVALUATION
*****

REPUBLIC OF CAMEROON
Peace – Work – Fatherland
*****
UNIVERSITY OF YAOUNDE I
*****
FACULTY OF EDUCATION
*****
DEPARTMENT OF CURRICULUM AND EVALUATION
*****

Dear respondents my name is ANONDA LARISSA NYOH I'm a post graduate student from The university of Yaoundé 1 faculty of education, department of curriculum and evaluation carrying out a dissertation on the topic **'the effectiveness of teaching methods on skill acquisition in STEM (Science Technology Engineering And Mathematics) education in some primary schools in Yaounde VI subdivision'**. Please kindly tick (the answer that best suits you amongst the four options agree (A), strongly agree (SA), disagree and strongly disagree (SD).

SECTION A: Background Information

SECTOR: Public ☐ Private ☐

LEVEL: 1 ☐ 2 ☐ 3 ☐

CLASS:

SEX: Female ☐ Male ☐

SECTION B: please tick the best alternative that suits your answer to the question.

	Questions	SD	D	A	SA
Project based learning and skill acquisition in STEM education					
1	In STEM lessons, authentic problems are identified.				
2	A project is identified to solve the problem				
3	Projects carryout are related to real life situations.				
4	Learners are wholly involved in the learning process.				
5	Learners are grouped together to solve problems.				
6	The teacher facilitates in the course of the project.				
7	At the end of the project, A concrete artefact is produce to solve the problem identified.				
Inquiry based learning and skill acquisition in STEM education					
8	STEM lessons begin with open ended questions from the teacher.				

9	Problems are identified by learners.				
10	A fixed method usually the scientific method is use to find solutions to the problem.				
11	Learners are grouped together to brainstorm, share ideas and propose solutions identify during STEM lessons.				
12	The teacher supervises and provides help when difficulties are encountered.				
13	STEM lessons end with discussion sessions where there's communication and reflection. .				
14	A report is provided at the end of each inquiry session by each group.				
Problem based learning and skill acquisition in STEM education					
15	Real world problems are identified during STEM lessons.				
16	Learners brainstorm solutions and guided by the teacher.				
17	Learners are grouped in different teams to solve the problem identified.				
18	Learning is concrete and hands on,				
19	Learners work in groups to communicate and share ideas.				
20	The teacher guides and facilitates the different phases of solving the problem.				
21	A prototype is produce at the end of the lesson to solve the problem identified.				
Skill acquisition in STEM education					
22	STEM lessons increase learners' to develop creative solutions				
23	STEM lessons aid the generation of new and innovative ideas.				
24	STEM lessons enable learners to think critically on how to solve problems.				
25	During STEM lessons learners work effectively in a team and collaborate with each other.				
26	Stem education enable learners to communicate both verbally and in writing.				