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Instructional Leadership Promotes Stem Education in Schools

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Abstract: STEM education is interested as an educational solution to train high-quality human resources for the country. For STEM education to be implemented well in schools, it is necessary to have the leadership and comprehensive guidance of the principal. At this time, the principal needs to equip himself with an instructional leadership style. Instructional leadership is a school leadership model in which the principal plays the role of guiding teachers, students, and staff in establishing an effective organizational structure for teaching and learning activities. For STEM education, leadership directly supports, advises, and helps teachers access methods of integrating science, technology, engineering, and mathematics into teaching and educational activities. Within the scope of this research, the author uses theoretical research methods to clarify the importance of school leadership, the role and meaning of STEM education, models, system of methods, and forms of development. promote effective STEM education in schools. The research contents clearly demonstrate the principal's role in guiding and directing teachers to integrate science, technology, engineering, and mathematics (STEM) into teaching and educational activities to develop students' quality and capacity, suitable to the context of the current knowledge economy. From there, it is concluded that instructional leadership is one of the leadership styles that promote STEM education in schools.

Keywords: Instructional Leadership, Promotes, STEM Education, Schools

1. Introduction

There is great interest in educational leadership in the early part of the 21st century. This is because of the widespread belief that the quality of leadership makes a significant difference to the school and student outcomes. In many parts of the world, including South Africa, there is recognition that schools require effective leaders and managers if they are to provide the best possible education for their learners. As the global economy gathers pace, more governments are realizing that their main assets are their people and that remaining or becoming, competitive depends increasingly on the development of a highly skilled workforce. This requires trained and committed teachers but they, in turn, need the leadership of highly effective principals and the support of other senior and middle managers [12].

While education can learn from other settings, educational leadership, and management have to be centrally concerned with the purpose or aims of education. These purposes or goals provide a crucial sense of direction to underpin school management [11].

2. The Importance of School Leadership

A central element of most definitions of leadership is that it involves a process of influence [22]. As Yukl has phrased it, “Most definitions of leadership reflect the assumption that it involves a social influence process whereby intentional influence is exerted by one person (or group) over other people (or group) to structure the activities and relationships in a group or organization” [62]. The term intentional is important, as leadership is based on articulated goals or outcomes to which the process of influence is expected to lead [7].

School leadership has become a priority in education policy

agendas internationally. It plays a key role in improving school outcomes by influencing the motivations and capacities of teachers, as well as the school climate and environment. Effective school leadership is essential to improve the efficiency and equity of schooling [7].

School leadership contributes to improved student learning. There is increasing evidence that within each school, school leaders can contribute to improved student learning by shaping the conditions and climate in which teaching and learning occur. A large body of research on school effectiveness and improvement from a wide range of countries and school contexts has consistently highlighted the pivotal role of school leadership in making schools more effective [53, 58].

School leadership bridges educational policy and practice. School leadership also plays a major role in education reform. Much has been written about top-down versus bottom-up strategies for school improvement and there is widespread agreement that the two need to be combined and synchronized [25, 32, 44]. For centrally initiated reforms to become meaningful to all school-level stakeholders, they need to be associated with internal school improvement activities in a coherent way [55].

School leadership links schools to their environments. School leaders are in charge of connecting and adapting schools to their surrounding environments. According to Hargreaves et al. (2008), school leaders will increasingly need to lead "out there" beyond the school, as well as within it, to influence the environment that influences their work with students [29]. School leaders play an important role in strengthening the ties between school personnel and the communities that surround them [25]. Leaders of the most successful schools in challenging circumstances are typically highly engaged with and trusted by the schools' parents and the wide community [29]. They also try to improve the achievement and well-being of children by becoming more involved with other partners such as local businesses, sports clubs, faith-based groups, and community organizations and by integrating the work of the school with welfare, law enforcement, and other agencies [48].

Leaders are people who shape the goals, motivations, and actions of others. Frequently they initiate change to reach existing and new goals. Leadership takes much ingenuity, energy, and skill [30].

Moreover, in rapidly changing societies, the goals and objectives to be achieved by schools and the ways to get there are not always clear and static. In increasingly globalized and knowledge-based economies, schools must lay the foundations for lifelong learning while at the same time dealing with new challenges such as changing demographic patterns, increased immigration, changing labor markets, new technologies, and rapidly developing fields of knowledge [7].

3. The Roles of Instructional Leadership

The leader of a school has a high level of responsibility to students, teachers, parents, and the community. Classroom teachers need a leader who will be supportive, motivating, and knowledgeable. A well-rounded principal will have a varied style of leadership that will draw on many different leadership models.

Instructional leadership is a pathway for setting and communicating a clear vision and goals for teachers and students and supporting teachers through coaching, mentoring, and professional development [50]. When a principal is an instructional leader, there are positive outcomes in student achievement [28, 49, 50]. The goal of the instructional leadership model is to promote student learning [16, 23]. In order to promote student learning, principals who enact instructional leadership will have a clear vision for their school and will communicate this vision to their staff [41]. Additionally, principals who are instructional leaders support teachers to improve their practice by giving them access to the resources that they require, coaching and mentoring them, and providing professional development opportunities, both formal and informal. Instructional leaders act as instructional resources to support teachers to improve their teaching practice.

Instructional leadership focuses on the direction of influence, rather than its nature and source. The increasing emphasis on managing teaching and learning as the core activities of educational institutions has led to this approach being endorsed, notably by the English National College for School Leadership [12].

Southworth (2002: 79) says that "instructional leadership... is strongly concerned with teaching and learning, including the professional learning of teachers as well as student growth" [54]. Bush and Glover's definition stresses the direction of the influence process: Instructional leadership focuses on teaching and learning and on the behavior of teachers in working with students. Leaders' influence is targeted at student learning via teachers. The emphasis is on the direction and impact of influence rather than the influence process itself [13].

The OECD report, Improving School Leadership suggests that effective school management generally comes from engagement in instructional leadership. There's a growing body of evidence that shows that schools with instructional leadership outperform others. This coaching style of leadership concentrates on student learning outcomes by improving teaching quality. To realize this goal, school leaders adopt the responsibility for the professional development of teachers. Instructional leadership involves the practice of planning, evaluation, coordination, and improvement of teaching and learning. Working directly with teachers, instructional leaders evaluate teacher performance and help advance their skills through mentoring and coaching. Becoming an instructional leader entails time spent solving pedagogical problems, taking action to improve teachers' instruction, as well as holding teachers accountable for improving their instructional skills. This pursuit to improve learning within the school community requires leaders to have an in-depth understanding of pedagogy and practice themselves [1].

Leadership in instruction is a very critical aspect as it addresses the core tasks, teaching, and learning of the school.

4. Instructional Leadership Promotes Stem Education

STEM education is a teaching approach that combines Science, Technology, Engineering, and Math. Instructional leadership has a significant influence on the promotion of STEM education. The leader oriented the implementation of the program's content, proposed methods, and forms of educational organization; guide the steps of testing and assessment suitable for STEM education. Instructional leadership enables teachers to integrate technology and techniques into the instructional process; promote scientific research and the application of mathematics; create conditions for teachers and students to have a collaborative approach to learning and connect with STEM education experts. Leaders guide the development of a STEM education environment, including facilities, information resources, documents, materials, refresher courses, training, and skills training for teachers.

To promote STEM education in schools, Principals - Instructional leaders need to equip teachers with the following issues:

4.1. Firstly, Properly Understand the Role and Meaning of STEM Education

STEM education is an educational perspective that is formed based on the need to train human resources to meet the fourth industrial revolution. "STEM stands for Science, Technology, Engineering, and Mathematics. The term is used when referring to a program to support and enhance education and development policies in Science, Technology, Engineering, and Mathematics of each country" [19, 52]. STEM education combines fields into a cohesive learning model that builds on real-world applications instead of teaching them as discrete and discrete objects [31].

A prosperous economy in the 21st century will be based on Science, Technology, Engineering, and Mathematics [40]. This sets out for the education sector the task of preparing qualified human resources in science, technology, engineering, arts, and mathematics, as a premise for the development of science and technology, improving the competitiveness of the economy, and meeting the increasing integration needs of all countries and ethnic groups [57]. STEM education has a positive impact on student learning, namely creating motivation to learn, and increasing positivity, sense of meaning, and enthusiasm in learning [17]. These help students maintain career direction and persistence in STEM fields [24]. Developing competencies in STEM fields is seen as an urgent goal by many education systems, in part due to the high demand for the current STEM workforce, now and in the future [15]. Success in STEM education can affect careers, work productivity, and competitiveness in many fields [6].

4.2. Second, Deploying the 5E Teaching Model in STEM Education

Since the late 1980s, BSCS (Biological Sciences Curriculum Study) has used one instructional model extensively in the development of new curriculum materials and professional development experiences. That model is commonly referred to as the BSCS 5E Instructional Model or the 5Es and consists of the following phases: engagement, exploration, explanation, elaboration, and evaluation. Each phase has a specific function and contributes to the teacher's coherent instruction and the learners' formulation of a better understanding of scientific and technological knowledge, attitudes, and skills. The model frames a sequence and organization of programs, units, and lessons. Once internalized, it also can inform the many instantaneous decisions that science teachers must make in classroom situations [14].

Engagement: The teacher or a curriculum task accesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.

Exploration: Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.

Explanation: The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.

Elaboration: Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop a deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.

Evaluation: The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

The reports show that the 5E model is effective for students in the process of learning STEM subjects. This model has also spread to many other countries and continents, to many different levels of teaching [2, 56].

The 5E approach provides opportunities for students to build new knowledge and express thoughts throughout the

learning process. Recent research also shows that the 5E model has produced "a significantly better scientific understanding than traditional guidelines." [61].

In addition, this model also helps to significantly increase learning outcomes and maintain a connection between science lessons [45].

4.3. Third, STEM Teaching Methods

4.3.1. Cooperative Education Method

Collaborative education (also known as group education) is an educational method in which teachers organize students to form small study groups, research together, exchange ideas, and solve problems set by the teacher. Thereby helping students absorb a certain amount of knowledge based on the active activities of each individual. Each member of the group is not only responsible for their own learning but also has the responsibility to care about the learning of their friends in the group [33].

A strong theoretical argument has been made [8] for the educational benefit of cooperatives because of the interaction of the academic and work-term experiences in co-op. Several articles [26, 59, 60] have also described the potential of the cooperative education model in supporting contemporary learning strategies such as problem-solving, experiential learning, and reflective practice.

4.3.2. Educational Method of Discovery

The exploratory educational method is understood as an educational method in which, under the guidance of the teacher, through activities, students self-explore, discover, and discover new knowledge in the classroom subject program [33].

The basis of science teaching is understanding that natural phenomena and the nature of science require inquiring and discovering. Inquiry in science consists of experiments and inquiring about natural phenomena by discovery learning [10, 39]. Bruner points out that any individual has the will to learn and this will should be used in such activities that it should raise curiosity and direct students to study and discover knowledge. Bruner (1961) states that learning happens by discovery, which prioritizes reflection, thinking, experimenting, and exploring. People who use self-discovery in learning turn out to be more self-confident [9].

Discovery is a way from the unknown to the known by the learners themselves [10]. The active participation of the learner in the learning process is called discovery learning [10, 34, 37]. In discovery learning, students construct knowledge based on new information and data collected by them in an explorative learning environment [21, 47].

4.3.3. Problem-Solving Method

The Problem-solving method is an educational point of view, students are placed in a problem situation, actively discover knowledge, and actively work to solve problems to acquire knowledge and practice skills. abilities and achieve other learning goals [27].

Developing and enhancing the ability of problem-solving and science-process skills of students have long been important objectives of science education [46]. In recent years, it can be seen that the problem-solving method is widely used in science teaching. The problem-solving method is the center of the science curriculum, which would affect the whole curriculum. This method which provides group work is student-centered. The problem-solving method makes a teacher a guide for regulatory problems as a stimulus for learning and provides development of the student's problem-solving skills and new information to learn self. In addition, this method is based on real-life problems. So, it provides information and to remember concepts more easily in the case of any problems encountered in the future [3]. Therefore, it is needed to improve students' skills in problem-solving [4].

4.3.4. Project Method

The Project method is a form of education in which learners perform a complex learning task, combine theory and practice, practice, and create products that can introduce. This task is performed by learners with high self-reliance throughout the entire learning process, from goal setting, and planning, to project implementation, to checking, adjusting, and evaluating the process [27].

The project is one of the standard teaching methods [5]. It is generally considered a means by which students can (a) develop independence and responsibility, and (b) practice social and democratic modes of behavior. The project method is a genuine product of the American progressive education movement. It was described in detail and definitively delimited for the first time by William Heard Kilpatrick in his essay, "The Project Method," which became known worldwide [18, 20, 35, 51].

In Kilpatrick's view, projects had four phases: purposing, planning, executing, and judging. The ideal progression was when all four phases were initiated and completed by the pupils and not by the teacher [36]. Only when the pupils exercised "freedom of action" were they able to acquire independence, power of judgment, and the ability to act-the virtues that Kilpatrick believed were indispensable for the maintenance and further development of democracy [38].

4.4. Fourth, the Form of Organization of STEM Education

4.4.1. Building a STEM Topic/Lesson, Including 04 Steps

Step 1: Choose a STEM lesson topic. Based on the content of knowledge in the course program and the phenomena and processes associated with such knowledge in nature; technological process or device that uses that knowledge in practice to select the topic of the lesson. Note that when choosing a lesson topic, you need to pay attention to the student's ability, level, and psychophysiology.

Step 2: Identify the problem to be solved. After choosing the topic of the lesson, it is necessary to determine the problem to be solved and assign it to students so that when solving that problem, students must learn the knowledge and skills that need to be taught in the subject program. have selected or applied known knowledge and skills to build lessons. Note

that the problem to be solved must be appropriate to the student's ability to apply technology and engineering as well as the level of mathematics.

Step 3: Develop device criteria or problem-solving solutions. Once the problem to be solved or the product to be manufactured has been determined, the criteria for the solution or product should be clearly defined. These criteria are an important basis for proposing scientific hypotheses, solving problems, and designing product samples. Criteria should be developed to specifically express the requirements of a STEM lesson topic for science, technology, engineering, and math content. Note that the criteria must also aim to guide the learning process and apply the students' background knowledge, not just focus on evaluating physical products.

Step 4: Design the process of organizing teaching activities. The process of organizing teaching activities is designed according to active teaching methods and techniques with 05 activities. Each learning activity is clearly designed in terms of the purpose, content, and learning product that students must complete. Such learning activities can be held both inside and outside the classroom.

Activity 1. Identify the problem. The teacher assigns the students a learning task that contains the problem. Which, students must complete a specific learning product with the criterion that requires students to apply new knowledge in the lesson to propose, and build solutions and solutions in the direction of STEM education; This means that students need to integrate the knowledge of one or more subjects, combining the application of engineering technology and mathematics to solve problems. Product criteria are a very important requirement, forcing students to master new knowledge of design and design explanations for the product to be made.

Activity 2. Research background knowledge and propose solutions. Teachers organize students to carry out active learning activities, increasing the level of self-reliance depending on each student under the flexible guidance of the teacher. In STEM lessons, students explore and acquire knowledge to use in proposing and designing products to be completed. Teachers are people who both guide and encourage students to experience discover and accumulate scientific knowledge, and practice technology, engineering, and math skills to meet the requirements of STEM education.

Activity 3. Choose a solution. The teacher organizes for students to present, explain and defend the design with explanations (using new and existing knowledge); it is the concrete representation of the solution to the problem. Under the exchange and suggestions of friends and teachers, students continue to perfect the design before proceeding to manufacture and test. The solution needs to fully meet the requirements of STEM education, which are the requirements of science, technology, engineering, and math.

Activity 4. Prototyping, testing, and evaluating. Teachers organize for students to make STEM products according to the design plan completed in step 3. During the manufacturing process, testing and evaluation must be carried out simultaneously. During this process, students may have to tweak the original design to ensure the prototype is viable. Note that during prototyping, testing, and evaluation, it is important to consider identifying elements of STEM education in the product.

Activity 5. Sharing, discussing, and adjusting. Teachers organize students to present finished learning products; exchange, discuss and evaluate for further adjustment and improvement [42].

4.4.2. STEM Experiences, Including STEM Club, STEM Festival, The STEM Competition, Scientific Research Activities, and Science Tours

STEM Club. The school's STEM club is an active learning environment, bringing together a team of teachers and students with similar interests in scientific research by applying interdisciplinary knowledge to solve real-world problems. The STEM club works by discovering problems, creating problems, receiving problems, proposing solutions to problems based on theories of science, applying technology, creating techniques, and combining math tools.

The STEM club is a place where students exchange, share, discuss problems, and solve problems appropriate to their age, ability, level, and psychophysiology. It can be said that the STEM club is an environment to discover, promote and develop the career potential of students.

Maintaining a STEM club is important in creating conditions for students to access a STEM education-oriented experiential learning environment; in accordance with the requirements of a fundamental and comprehensive reform of education in order to develop the quality and capacity of students.

STEM Festival. STEM Festival is a form of organizing experiential activities through events, to create opportunities for students to express their ideas and creativity in integrating science, technology, engineering, and math. into solving a specific problem or making a product for learning and life. STEM Festival is a form of learning while having fun, the result of scientific research, and product announcement after the research process. Coming to the STEM festival, students have the opportunity to learn from each other, and exchange research experiences with each other; Students explore, discover, ask questions, and conduct interviews based on product observations, thereby consolidating old knowledge, forming new knowledge, expanding their need for knowledge, and improving practical skills.

The STEM Competition. The STEM competition is a form of experiential activity oriented to STEM education to attract students to actively participate and demonstrate their ability to integrate interdisciplinary science and apply technology, engineering, and math. study to meet the requirements of the competition. The content of the STEM competition meets the needs of students for entertainment, talent demonstration, creativity, mutual learning, and learning competition. Through the STEM competition, students develop their ability to be proactive, form learning motivation, arouse interest in the cognitive process in a scientific way, and know how to approach technology, engineering, and math tools to learn to solve practical problems.

Scientific research activities. Students who study science

are not scientists but become acquainted with scientific research methods. In which, methods of observation, analysis, synthesis, statistics, and generalization... are basic methods to study the laws of motion of things and phenomena occurring in the natural world. The orientation of STEM education helps students make the most of their scientific knowledge, and skills in applying technology, engineering, and mathematics to specifically solve a real-world problem.

Science tours. Science tour oriented to STEM education is an experiential activity at high schools, colleges, and universities with STEM function rooms and STEM spaces; companies, factories, and enterprises operating according to high-tech processes such as robots, applying artificial intelligence to production lines... This form of scientific sightseeing actively contributes to the formation of the world's scientific worldview, technical thinking, and career orientation for students in the trend of Industry 4.0 integration.

4.5. Fifth, Assessment in STEM Education

Evaluation of activities in STEM education needs to adhere to the principles of ensuring validity; ensure comprehensiveness and flexibility; ensure fairness and trust; assessment should be concerned with the results and the learner's process to get those results; assessment in a practical context for the development of learners. Assessment in STEM education is carried out in 07 steps: Step 1: Determine the assessment purpose, and the topic objective to be assessed. Step 2: Develop an assessment plan. Step 3: select and design assessment tools. Step 4: Perform an evaluation test. Step 5: analyze and process the evaluation results. Step 6: interpret and respond to evaluation results. Step 7: use the results in developing the quality of students' competencies [43].

5. Conclusions

Instructional leadership plays an important role in promoting STEM education in schools. Instructional leaders communicate visions and goals for their schools, focusing on teacher and student achievement; create conditions for teachers to develop professional skills, and students to develop creative scientific thinking. STEM education outcomes reflect leaders' ability to guide access to science, technology, engineering, and math for teachers and students. Therefore, the Principal - Instructional leadership positively affects the performance of teachers and the learning outcomes of students in the direction of STEM education.

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