Journal of Education and Learning (EduLearn)
Vol. 20, No. 4, November 2026, pp. 2206~2214
ISSN: 2089-9823, DOI: 10.11591/edulearn.v20i4.27319

School management strategies to address the constraints experienced by secondary school science teachers for effective instruction

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Article Info

Article history:

Received Jan 7, 2026
Revised Apr 3, 2026
Accepted Jun 8, 2026

Keywords:

Professional development
School management
Science education
Science teaching
Teacher motivation

ABSTRACT

This study examines the constraints science teachers face in secondary schools for effective science teaching and the role of school management in facilitating them. It assumes that teacher motivation is a key factor influencing the quality of science teaching and learning, and that school management plays a vital role in influencing teacher motivation. It employs a convergent parallel research design using telephonic unstructured interviews, online focus group discussions, and Google Form surveys. A sample of 44 respondents, of which six school principals, eight heads of science departments, and 30 science teachers from six secondary schools, was used. The study reveals the major factors affecting teacher motivation: i) a lack of qualified laboratory technicians; ii) a bulky science curriculum, science teachers teaching out-of-the-subject area; iii) a lack of innovative pedagogies, autonomy, resources; and iv) a safe work environment. The research concludes that school management should adopt a transformational leadership style, provide adequate and relevant professional development opportunities, give constructive and timely feedback, recognize and reward teacher performance, grant teachers more autonomy and voice, and create a supportive and collaborative work environment. The Ministry of Education should decentralize education with more teacher choice and school leaders' voice in teaching and leading science subjects.

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1. INTRODUCTION

In a constantly changing world, rapid advancements in science and technology impact educational processes globally, including in Mauritius, a small island state in the Indian Ocean. The government's objective is to educate the population about these changes and prepare them for the information age. Scientific and technological literacy is highly prized in Mauritius. It empowers residents to contribute to national and human development. Science education has undergone a significant shift from traditional teacher-centered paradigms to holistic and learner-centered approaches. STEM education merges science, technology, engineering, and mathematics into a comprehensive framework that prepares students for the challenges of the 21st century. It is the most interesting example of this transition [1], [2].

The Ministry of Education and Human Resources, and the school management share the responsibility of creating a conducive learning environment by providing educators with up-to-date facilities across various fields of study [3], [4]. This preparation aims to equip students for the future [5]. Moreover, the importance of school management is highlighted in the National Curriculum Framework 2015, which states that school heads must provide science teachers, in particular, with adequate infrastructure and resources, enabling classrooms and specialized skills and competencies to ensure quality science teaching and sustainability [6].

Given the significant shifts caused by the COVID-19 pandemic and the widespread adoption of technology in education, school management must ensure that science teachers are well-equipped with tools and receive the necessary support to facilitate effective teaching and student engagement. The latter must also be provided with a set of intentional and explicit opportunities beyond the implicit element of science instruction [7]. The unwavering backing from school management motivates science teachers to enhance their teaching methods and find ways to ignite learners' appreciation for scientific concepts. The leader should provide high-quality learning experiences, monitor the curricular program, create a safe school environment, distribute leadership to advance science instruction, provide support, recruit qualified science teachers, and offer quality teacher professional development programs to them [8]. Motivated teachers, in turn, inspire students to engage actively in learning, ultimately contributing to the school's overall performance [9]. Indeed, there is a significant positive relationship between transformational leadership and teacher commitment [10]. This is underlined by the four core components of transformational leadership theory [11], namely idealized influence, intellectual stimulation, individual consideration, and inspirational motivation. The science teacher's motivation arises from the principle that the leader transforms and inspires followers to perform beyond expectations while transcending self-interest for the good of the organization [12]. From this perspective, school management, particularly school heads, plays a facilitating role in enhancing teachers' motivation levels.

Science educators in Mauritius face numerous challenges in secondary schools. Despite continuous requests by the former and heads of science departments for measures to improve science teaching, poor responses from management led to lower teacher motivation. Day *et al*. [13] asserted a positive link between supportive organizational climate and social support. Furthermore, high-quality science education increases scientific literacy and motivates students to choose science in college. A decline in the number of students who opt for science subjects, mainly biology, was observed in the country [14]. This is likely to affect the country's reliance on human capital. Other contributing factors are students' lack of interest in science, the imposed parental choice of non-science subjects for their children, traditional and teacher-led teaching approaches, and limited student engagement in science activities [15]. Resource constraints and equitable access to them are also demotivating for science teachers to ensure quality teaching and learning [16].

School management adopts actionable strategies to motivate teachers to improve teaching and learning science in their classrooms. It should provide up-to-date science labs and equipment. Pareek [17] asserted that the quality of science instruction depends on adequate laboratory facilities and their optimal utilization by teachers to produce meaningful and enriching learning experiences. Moreover, the provision of modern, well-equipped laboratory facilities with adequate resources contributes to the quality and effectiveness of science education [15]. However, school laboratories can pose potential risks and hazards like radiation, electricity, fire, equipment malfunction, biological agents, and exposure to chemicals [18]. From this perspective, the school management provides medical assistance and first aid to teachers, as well as the provision of safety in the labs, training teachers on the use of safety, health, and precautionary measures in emergency and unforeseen situations of fires, disasters, and crises [19]. Principal leadership has a significant positive effect on student achievement in science in all contexts, but the effect size varies according to the context [20]. Khwanchai *et al*. [21] came forward with an instructional design model that promotes the integration of the cultivating research-based learning (CRL) approach and the inquiry-based learning (IBL) approach in an attempt to enhance scientific literacy among science secondary school students. Indeed, the CRL approach has a significant positive impact on students' scientific literacy and learning satisfaction. Laid and Adlaon [16] maintained that the school head should provide science teachers with opportunities to promote hands-on learning, technologically-integrated, and student-centered teaching approaches. Hands-on learning experiences that can be provided to the science students through the leadership of the school heads are lab experiences, fieldwork, and the adoption of project-based learning strategies. These experiences considerably enhance students' understanding, active participation, and the retention of scientific concepts in the long-term memory [22], [23]. On the other hand, technology integration involves the use of virtual labs, simulations, and interactive software. These digital and personalized learning tools not only facilitate the visualization of abstract scientific concepts but also promote inquiry-based and adaptive learning. This enables students to do virtual experiments and solve real-world problems [24], [25]. Student-centered strategies that the school management could encourage science teachers to adopt are inquiry-based learning, gamification, and peer collaboration. Hence, students may actively explore scientific problems, formulate hypotheses, conduct experiments, and draw conclusions [26], [27].

Few studies have examined the relationship between school management and science teacher motivation in Mauritius. This lack of scholarship and research hinders the ability of science teachers to ensure effective science teaching and learning, and the decline in student academic achievement remains an alarming situation in the national education system. The research aims to fill this gap by understanding how school management affects science teaching. It will provide insights for policymakers to improve the functioning of the science department and for science teachers to deal with management to boost their motivation [28]. The research objectives of this study are: examine the constraints science teachers experience when teaching science in secondary schools and recommend strategies that school management can adopt to enhance the teaching of science in secondary schools

2. METHOD

This study adopted a convergent parallel research design, which is exploratory in nature. Data was collected in six secondary schools, located in the south of the country, with six principals (heads of schools), eight heads of science departments (HoSDs), and 30 science teachers. Unstructured interviews were conducted with the principals, a focus group discussion with the HoSDs, and a survey questionnaire with the Science teachers. The data were collected and analyzed simultaneously to facilitate triangulation and ensure the trustworthiness of the findings. The population comprised 441 staff, and purposive sampling was used. The profile of the participants in Table 1 ensures the transferability of the findings to a similar educational context. The findings cannot be generalized due to the survey's limited sample size. The samples for each category of participants were:

Table 1. Profile of participants

Schools	Categories of participants	Number selected	Gender
A	Principal	1	Female
	HoSD (science)	1	Male
	Science teacher:	2	Males
		3	Females
B	Principal	1	Male
	HoSD (science, biology)	2	Female
	Science teacher:	2	Males
		3	Females
C	Principal	1	Male
	HoSD (science)	1	Female
	Science teachers:	2	Males
		3	Females
D	Principal	1	Female
	HoSD (science, chemistry)	2	Female
	Science teachers:		Male
		2	Males
		3	Females
E	Principal	1	Female
	HoSD (science)	1	Male
	Science teachers:	1	Male
		4	Females
F	Principal	1	Male
	HoSD (science)	1	Female
	Science teachers:	3	Males
		2	Females
Participants: 44			

Regarding the gender distribution, 40% of the science teachers who participated in the survey were males, and 60% were females. In terms of age, 17% of the respondents were above 50 years old, 37% were between 41-50 years, 30% were between 31-40, and 16% were between 21-30. With respect to educational qualifications, 30% of the science teachers were holders of a master's degree, 40% possessed a bachelor's degree, and 30% possessed a post graduate certificate in education (PGCE) in science education. Regarding teaching experience, 47% of respondents had more than 11 years of science teaching experience, 23% had 6-10 years, 20% had 3-5 years, and 10% had less than 2 years of experience.

All the ethical issues related to the study were considered by referring to the Ethical guidelines of the Open University of Mauritius, the Data Protection Act 2017 of Mauritius, and the British Educational Research Association 2024. The quantitative data were analyzed using SPSS Version 29.0. After the unstructured interviews and the focus group discussion were completed, the audio recordings were transcribed. The interview transcripts were downloaded and encrypted onto a password-protected computer for confidentiality and data protection purposes. The ATLAS.ti software was used for processing and analyzing the qualitative data. The reflexive thematic analysis (RTA) by Braun and Clarke [29] was used to develop themes, and this technique involves identifying, analyzing, and reporting the themes or patterns that emerge from the data. The RTA is recursive and iterative, and the researcher moves back and forth through the phases as necessary [30].

3. RESULTS AND DISCUSSION

Themes were developed and generated from the data, and they are discussed along with the findings from the questionnaire survey in this section. This analytical approach ensures that the findings are trustworthy, based on the triangulation of the sources of the data and information gathered, and those of previous studies.

3.1. Constraint's science teachers experience when teaching science in secondary schools

3.1.1. Inadequate and faulty laboratory equipment

In the selected secondary schools, it was found that many of the science equipment in the laboratories are faulty, and when the school management is recommended to provide new ones, supplies to the school are often delayed. All the principals confessed that they provided their science teaching staff with the necessary equipment. From this perspective, school principal D gladly highlighted: "*Every three months, I meet all the staff in the science department, including my science HoSDs, and we make a list of all the consumables that are out of stock and equipment that needs to be bought for practical classes.*" However, the survey showed that 48.1% of science teachers confirmed that they were provided with resources and equipment for science teaching, but the provision was inadequate for effective science teaching and learning. This inadequacy is explained by the administrative slack of the Zone Directorate. School principal B, with a harsh tone, stated: "*Once I obtain the list of missing equipment and chemicals from the HoSDs of science, I will forward the list to the Director of Zone, who will make the necessary arrangements via the Ministry of Education and suppliers. However, it pains me to say that this procedure may take several months just to obtain the equipment, which demotivates science teachers to do their job efficiently*." The finding confirms the research of United Nations Educational, Scientific and Cultural Organization or UNESCO, which states that a shortage of equipment such as desks, books, computers, and other teaching materials can frustrate teachers and cause drops in motivation [31], [32]. The laboratory equipment was also not aligned with the science curriculum. HoSD6 interrupted the discussion by adding: "*I used to give my list of equipment to the school principal who forwarded it to the manager of the school. The latter used to buy the equipment from abroad, which was cheaper, and once I received the orders, many of them were defective and fragile. Students very often faced difficulties working with them.*"

Among the teachers surveyed, 76.7 % of teachers approved the fact that laboratory equipment and resources should be in accordance with what is prescribed by the Ministry of Education. Consistently, Bernhard [33] maintained that for meaningful practical activities and experiments in science, the equipment and experiments have to be carefully selected and provided adequately. This is the instructional leadership role of school leaders: resource-provider [34].

3.1.2. Lack of qualified laboratory technicians

The study revealed a lack of qualified laboratory technicians in the selected schools. They lack training in the operation of a science lab. The school principals unanimously agreed that most of the laboratory technicians are not sufficiently knowledgeable of laboratory work. This claim was justified by school principal C with a desperate tone: "*The basic requirement for recruiting laboratory technicians in secondary schools is proof of having sat for the School Certificate (SC) Cambridge examination, which is not necessarily a pass. Upon appointment, the new laboratory technicians are introduced to the HoSD who then explains their duties and introduces them to the equipment, chemicals, and practical setups in the laboratory*." In this regard, HoSD1 and HoSD4, with an annoying tone, pointed out: "*Despite the heavy workload that we have as HoSDs, we need to train the laboratory technicians who came with little knowledge of science. It can take at least one to two years to prepare laboratory technicians to understand and prepare solutions and chemicals*." In the same vein, HoSD2, a chemistry teacher, added: "*Once I have already trained my laboratory technicians to work in the chemistry lab, there is a system of reshuffling of laboratory technicians among the biology, chemistry, and physics labs in public schools. I find it really demotivating that each time I need to spare my time to keep on training people*." A high percentage of science teachers showed their dissatisfaction and demotivation towards working with their laboratory technicians. The survey indicated 53.3% of the science teachers confirmed the lack of qualified technicians accompanying them during their practical sessions. Furthermore, 63.3% of them stated that they are not satisfied with the work of their laboratory technicians since they often have to perform the duties of the laboratory technicians. In their study, Adams and Hamdhiyya [8] also found that school leaders should employ qualified people to work in the science department.

3.1.3. Lack of time for completion of the bulky science syllabus

Most of the school principals agreed that the science curriculum of grades 10 to 13, compared to other subjects, contains a substantial number of chapters to cover in two years, which renders the task of science teachers difficult. For instance, in grade 13, there are 37 chapters in chemistry and 19 chapters in biology, compared to 11 in economics and 10 in business studies.

So, science teachers experience much stress in covering this syllabus on time, when they also have to participate in several science activities and organize science fairs for students. Both HoSD1 and HoSD6 supported this constraint: "*Besides cyclonic weather conditions, timetable issues, and bulky syllabus, we have to participate in science activities, which consume another 1-2 months of work with the students. If we do not participate in extra-curricular activities, we will need to explain in writing to the manager. How would you expect us, science teachers, to complete the syllabus?*"

The survey revealed the stressful and demotivating situation among the science teachers. Among the respondents, 86.6 % of them considered the science curriculum to be very bulky and difficult to complete on time. Only 13.4 % rarely found it bulky. Indeed, teachers find it challenging to cope with a bulky scientific content and inquiry-based teaching strategies, and they are unable to complete it on time during the academic year [35].

3.1.4. Teachers teaching out of their subject area

In the Mauritian education context, science teachers are recruited on the basis that they possess a first degree in any one science subject, chemistry, biology, or physics. A secondary school teacher must be given a teaching load, as recommended by the authorities: "*Educators (secondary) should continue to teach for approximately 1190 minutes in a week, one or more subjects relating to their academic qualifications.*" [5]. This recommendation has negative implications for the subjects taught by teachers. This situation is illustrated by the statements of school principals of the selected private secondary schools.

On one hand, school principal A pointed out: "*At times, when we prepare the science timetable, some teachers do not get a full workload due to a reduced number of students, so they are asked to teach their subjects in two different schools*." All the HoSDs from public secondary schools were unanimous on the fact that they do not teach other subjects except their specialized subject area. However, school principal E desperately contrasted the opinions of the two previous participants by claiming: "*In private schools*, *if a Mathematics teacher has a science subject in his teaching license till grade 13, the school principal can give him a science class to teach*." Nearly all the HoSDs in the private sector agreed that they had to teach another subject if the number of students opting for science at grades 10 and 12 is low. The survey showed that 73.3 % of science teachers confirmed that they feel demotivated when they are instructed to teach other subjects. This finding is consistent with the study of Wong [36], which found that such teachers face numerous challenges, such as a lack of time management, inability to adapt teaching skills and knowledge, and a lack of patience.

3.2. Strategies that school management can adopt to enhance the teaching of science in secondary schools

3.2.1. Technology integration in science classes

This study showed that most of the selected secondary schools in the South of Mauritius prohibited the use of mobile phones during the teaching period. However, research has shown that excessive smartphone use, time spent on the phone, and excessive texting are all predictors of academic performance [37]. The survey indicated that science teachers are convinced that various technological tools, including videos, PowerPoint, projectors, mobile phones, illustrations, simulations, and virtual labs, improve science teaching. Among the teachers, 43.3% of the teachers preferred using videos in their classes, while 23.3% preferred PowerPoint presentations. Animated videos engage pupils and simplify content, and help model science and creative processes for real-world applications [38]. Therefore, the school management may provide technology-assisted learning opportunities, AI-powered virtual assistants, augmented and virtual reality tools, structural data molecular representations, intelligent tutoring systems, real-time and intelligent feedback cycles in online and hybrid learning environments, with immersive media [39], [40].

3.2.2. Parental involvement as a way to enhance science teaching

This study found that parent involvement in science learning is crucial in their children's academic success. The school principals, heads of science departments, and teachers were all unanimous about the importance of parent involvement in STEM in general, but in science, in particular.

School principal F, convincingly posited: "*Here in my school, we have many parents who constantly ask my teachers and me about the performance of their child, and I find this very encouraging*." From the focus group discussion (FGD), all the HoSDs agreed that parents' involvement in the school has a beneficial effect on their motivation as teachers. They considered that when parents actively support them, they feel pleased to teach their children. Moreover, the teachers are in favor of parent involvement in science teaching. 30% of them found it to be done through school journals, 13.3 % of them identified project work, 13.3 % identified copybooks, and 10% regular meetings with parents at school. This finding is consistent with the findings of Gülhan [41] that family participation in science teaching and learning should be facilitated by the school management, as it increases students' scientific literacy [42].

3.2.3. Professional development training for school principals and science teachers

The study revealed that professional development is essential for effective science teaching by teachers. The teaching of science is conducted in STEM, so teaching strategies evolve. School principal D proudly advocated: "*As a novice school principal, I faced many hurdles in dealing with teaching and non-teaching staff. However, after I followed a two-year course on educational leadership and Management at the Open University of Mauritius, I learnt a lot of things which transformed me into an effective leader.*" In the same vein, school principal A highlighted: "*After I followed the Post Graduate Diploma in Educational Leadership and Management course at the Mauritius Institute of Education, I started believing in myself, and I can say I can manage my school effectively now*." It is, therefore, obvious that professional development positively impacted the instructional leadership skills of the school heads. The importance of professional learning as a principal factor in motivating science teachers was evident in the findings of Sahlin [43].

Science teachers suggested professional development programs to enhance science teaching in Mauritius. The survey indicated that educational training in science teaching (23.3%) is the most favored method, followed by workshops (20.0%), peer science teaching (16.7%), departmental meetings (13.3%), and intercollege science competitions (3.3%). HoSD3 posited: "*When I first joined teaching, my class was most of the time teacher-centered. But after following the PGCE course at the Mauritius Institute of Education, I encourage group work, activities, and role playing in class to engage students to improve the teaching of science.*" In addition, HoD1 satisfactorily mentioned with an optimistic voice: "*After following the PGCE course and the Med in Leadership and Management at Open University of Mauritius, I feel I have grown. I manage my department well and try to resolve issues in a diplomatic way to minimize the risk of conflict among my science teachers*." It is obvious from this study that the school management should facilitate professional development programs in science teaching and learning for teachers. Teachers should engage in both theoretical learning and practical workshops, and be distributed across multiple sessions, to enable planning, execution, and experience sharing among themselves [44].

4. CONCLUSION

This study examined the influence of school management on teacher motivation to enhance the teaching of science in selected secondary schools of Mauritius. The findings revealed that school management plays a vital role in influencing science teacher motivation, which in turn affects the quality of science teaching and learning. The study also identified the factors that hinder teacher motivation and ability to teach science. Based on the results, the study proposed recommendations to improve school management practices and teacher motivation and ability in science education, particularly in the Mauritian context. However, it has some limitations: the findings cannot be generalized to all secondary schools in Mauritius, the sample size for the interview is too small, and the statistical analysis of the data is limited to descriptive analysis.

The study has contributed to the existing literature on school management and science teacher motivation, and it provided useful insights for policymakers, school leaders, heads of science departments, science teachers, and researchers in science education. In the context of STEM, the teaching of science is interrelated to the integration of technology, engineering and mathematics, requiring the teachers to be equipped with the innovative competences related to these four domains: critical thinking, adaptive teaching and learning approaches, creativity, reasoning skills, problem solving skills, that have all proved to be essential in the development of science teachers into better teachers. However, the success of this endeavor is only achievable with the support of the school management, which plays important roles of resource providers, professional development programs organizers, instructional leaders, and, most importantly, transformative leaders.

FUNDING INFORMATION

No funding was involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Louis Jinot Belle	✓	✓		✓					✓	✓	✓	✓	✓	
Punjoo Nooruddeen	✓	✓	✓		✓	✓		✓	✓		✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

No conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to human use has been conducted in accordance with all relevant national regulations and institutional policies, as outlined in the tenets of the Helsinki Declaration, and has been approved by the authors' institutional research ethics committee.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, [LJB]. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions.

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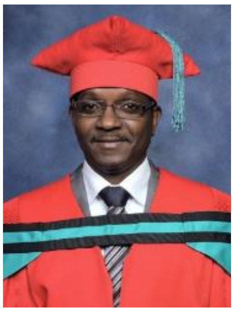

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