STEM Teachers' Levels of Intrinsic Motivation and Environmental-Based External Constraints on Intrinsic Motivation as Predictors of Mathematics Achievement Among Secondary School Students in Rwanda

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Abstract

This study investigates the extent to which the intrinsic motivation levels and environmental-based external constraints of intrinsic motivation of secondary school teachers in Rwanda (n = 91) are related to the achievement levels of their students in mathematics (n = 2,828). Employing hierarchical linear modeling, findings revealed that intrinsic motivation associated with the teaching profession is positively related to student outcomes, while environmental-based external constraints is negatively related. These findings highlight the complex dynamics of teacher motivation and its critical role in educational achievement, suggesting that enhancing teacher motivation and alleviating environmental constraints might improve student learning outcomes in Rwanda.

Keywords: teacher motivation, intrinsic motivation, teaching profession motivation, environmental-based external constraints on intrinsic motivation

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Introduction

The pivotal role of highly motivated teachers as a cornerstone for quality teaching and successful learning has been increasingly recognized over the past 20 years. Reflecting this recognition, the past two decades have seen an escalating interest among scholars in exploring the essence, origins, and impacts of teacher motivation (e.g., Bardach & Klassen, 2021; Butler, 2007; Watt & Richardson, 2007) across various sociocultural contexts (Han & Yin, 2016). Drawing on a variety of motivational theories, researchers have unearthed significant connections between teacher motivation and several pivotal teacher-centric outcomes. These include enhanced self-efficacy, increased job satisfaction, improved well-being, active participation in continuous professional development, and a deepened commitment to the profession (e.g., Calkins et al., 2023; Janke et al., 2019; Lauermann, 2017; Liu & Onwuegbuzie, 2014; Richardson et al., 2014). This line of research also extends into African educational spheres, with contributions from Christian and Sayed (2023), Heystek and Terhoven (2015), Kagema (2018), and Nwakasi and Cummins (2018) underscoring its global relevance. Contrastingly, the link between teacher motivation and student outcomes, such as academic achievement, presents a more complex and less consistent picture, as noted by Bardach and Klassen

(2021). In fact, the relationship between teacher motivation and the performance of students often has been minimal or nonexistent, a point underscored by Bardach et al. (2021), suggesting that the nuanced challenge of connecting teacher motivation directly to student performance merits further scholarly examination. This inconsistency has led Bardach and Klassen (2021) to assert that "The struggle of teacher motivation research to show consistent links with student outcomes thus deserves closer attention" (p. 283).

Teacher Motivation in Rwanda

In Rwanda, the quest to understand and to enhance teacher motivation is equally pivotal, reflecting a broader commitment to educational excellence that has been evident since 1979. During this period, Rwanda has embarked on numerous ambitious reforms aimed at transforming its education system. In response to the significant growth of secondary education and the pressing demands for continued reform, the Mastercard Foundation, through its visionary Africa *Works Strategy*, unveiled the *Leaders in Teaching* initiative. This strategic program is designed to elevate the quality, relevance, and equity of secondary education teaching in Rwanda. At the heart of the Leaders in Teaching initiative are four foundational pillars, among which is a dedicated focus on elevating the stature of the teaching profession and invigorating teacher motivation. This is achieved through strategic recognition and active public engagement, underscoring the initiative's holistic approach to fostering an environment where teachers feel valued and motivated.

A few researchers have examined the role of teacher motivation in Rwandan schools. Monaco (2016) specifically highlighted that the demotivation of teachers, especially in rural Rwandan schools, poses a significant challenge. Bennell and Ntagaramba (2008) further quantified this issue, revealing that 40% of teachers concurred with the assertion that "teachers at my school are increasingly demotivated" (p. vii). Additionally, reports from the Ministry of Education in Rwanda (MINEDUC, 2018) and a district-level study in Nyamagabe district (2020) both underscored the pervasive issue of low teacher motivation in secondary schools across Rwanda and specifically in the Nyamagabe district. These reports highlight a common thread: a substantial number of teachers across Rwanda, and notably in the Nyamagabe district, are struggling with low levels of motivation. This challenge is compounded by the observation that many headteachers appear to be applying their motivational strategies with limited effectiveness, an issue also identified in the research conducted by Byukusenge et al. (2022).

The report of Nyamagabe district (2020) shed light on a concerning trend among teachers between 2016 and 2019: an estimated 7% of teachers consistently failed to attend school, while 30% reported late for duty on a daily basis. These findings were interpreted by the researchers as a manifestation of dwindling motivation levels among educators. Echoing this sentiment, a Save the Children study in 2011 identified habitual absenteeism and tardiness as hallmarks of a demotivated teaching force, which adversely impacts student academic achievement. Further, a notable issue was identified among headteachers in public secondary schools, who often mirrored this lack of punctuality and presence, thereby failing effectively to inspire motivation among their staff. In contrast, an investigation by Gatsinzi et al. (2014) in Gasabo district's primary schools painted a more optimistic picture. This study revealed that primary school teachers exhibited higher motivation levels, attributed to increased responsibilities, supervision, and recognition of their efforts, underscoring the importance of supportive leadership in fostering teacher motivation, and, by extension, teaching quality. Moreover, using a small sample (i.e., n = 58), Aimable and Cyprien (2022) reported a relationship between teachers' motivation and learning effectiveness in Burera district. Further, Esdras and Andala (2021) documented a relationship between teacher motivation and teacher performance for both teachers and head teachers of boarding secondary schools, as measured by self-reported levels of attendance, punctuality, and achievement of curriculum objectives.

Within the framework of the Leaders in Teaching initiative aimed at enhancing the quality, relevance, and equity of secondary teaching in Rwanda, Carter et al. (2021a, 2021b) employed qualitative research approaches to explore the contextualised perceptions of teaching quality within Rwandan secondary schools. Specifically, via conducting 18 focus group discussions (FGDs) across five distinct stakeholder categories—namely, trainee teachers, early career teachers, late career teachers, teacher trainers, and deans of studies—Carter et al. (2021a, 2021b) observed a consensus among all five stakeholder groups regarding the critical role of teacher motivation in the realm of teaching quality in Rwandan secondary schools. Interestingly, it was the more experienced, late career teachers who most emphatically underscored the critical role of teacher motivation.

Building on these insights, Carter et al. (2022) pursued further investigation, organizing semi-structured interviews with 5 headteachers and 11 government officials across three districts in Rwanda to gather their perspectives on what constitutes teaching quality. This subsequent inquiry highlighted teacher motivation as a key subtheme, categorizing it as a vital non-academic skill within the educational landscape. A noteworthy observation from this phase was how the four participants and both head teachers and government officials articulated the concept of motivation: as a teacher's intrinsic drive towards fostering student growth through the relentless pursuit of knowledge and capacity enhancement. This endeavor to facilitate student growth can be classified as embodying *intrinsic motivation*. Additionally, government officials highlighted that teacher motivation is considerably influenced by external elements, like teacher salaries. These external elements are indicative of *extrinsic motivation*. Therefore, these findings clearly distinguish between intrinsic and extrinsic motivational factors influencing the educational landscape in Rwandan secondary schools.

Deconstructing Teacher Motivation

The findings documented by Carter et al. (2022) unveil a nuanced understanding of teacher motivation within the Rwandan secondary educational sphere, highlighting the pivotal roles played by both intrinsic motivation and extrinsic motivation. This insight aligns with previous research conducted in Rwanda, including studies by Bennell and Ntagaramba (2008), Carter et al. (2021a, 2021b), Monaco (2016), the Ministry of Education (MINEDUC, 2018), and the Nyamagabe district (2020), which also highlighted the significance of these motivational dimensions. These observations lend support to the applicability of Herzberg et al.'s (1959) Motivation-Hygiene Theory within the Rwandan secondary school setting, offering a compelling lens through which to view teacher motivation. Herzberg's two-factor theory delineates two separate groups of factors that influence an employee's motivation level. The first group, termed as motivators—equivalent to intrinsic motivation—encompasses achievement, recognition, the nature of the work itself, responsibility, along with opportunities for growth and advancement. These factors are highly interconnected and relate directly to the job's essence and conduct, fostering a sense of psychological development, self-fulfillment, and positive job attitudes.

Herzberg et al. (1959) categorized the second set of factors influencing employee motivation as hygiene factors, which are extrinsic to the actual work itself, including job status, security, compensation and benefits, supervision quality, the physical working environment, organizational policies, management practices, and the quality of interpersonal relationships with superiors, colleagues, and subordinates. A lack or perceived inadequacy in these extrinsic factors can lead to dissatisfaction among employees, potentially diminishing or obstructing their performance. These factors become particularly motivating when employees believe that their fundamental needs are not being met (Hilmi et al., 2016). Within the Rwandan secondary school context, salary has been highlighted as a critical extrinsic factor affecting teacher motivation (Byukusenge et al., 2022; Gatsinzi et al., 2014; Muvunyi, 2016; Nizeyimana et al., 2021), underscoring the necessity to address teacher compensation in Rwanda effectively.

The Differential Roles of Intrinsic Motivation and Extrinsic Motivation on Student Outcomes

The research literature on teacher motivation and student achievement indicates a nuanced relationship between intrinsic motivation and extrinsic motivation and their impacts on student outcomes. Although both types of motivation are important, evidence over the last two decades suggests that intrinsic motivation in teachers plays a more significant and lasting role in enhancing student achievement compared to extrinsic motivation (Ryan & Deci, 2000a). The significance of intrinsic motivation extends to the adoption of student-centered teaching practices and the establishment of a supportive classroom setting that emphasizes mastery and personal development, and wherein students work independently and enthusiastically (Serin, 2018).

A body of research supports the idea that intrinsic motivation in teachers is associated with higher student achievement (Akhtar et al., 2017; Howard et al., 2020). For example, researchers have found that teachers' intrinsic motivation is related to higher levels of student engagement, better classroom management, greater responsiveness to the educational needs of their students, and more effective and innovative teaching strategies (e.g., Fidan & Oztürk, 2015), which, in turn, promote student achievement (Jang et al., 2010). When teachers are intrinsically motivated, they are more likely to cultivate a classroom environment that supports autonomy, competence, and relatedness, which are key components of fostering intrinsic motivation in students as well (Niemiec & Ryan, 2009). Further, teachers driven by intrinsic motivation—marked by enthusiasm (Kunter, 2013), creativity (Hennessey, 2015), and a profound engagement with the teaching and learning process (Jang et al., 2010)—not only excel in their pedagogical practices but also significantly impact student learning experiences and achievements.

In contrast, extrinsic motivators can be effective in certain contexts. In particular, extrinsic rewards can motivate teachers to a certain extent, especially in the short term or in situations where intrinsic motivation is low; however, they might not sustain long-term commitment to high-quality teaching. Further, although extrinsic motivators can influence teacher behavior and effort to some extent, their impact on student achievement generally is considered to be less direct and less sustainable over time compared to intrinsic motivation (Serin, 2018). Extrinsic motivators might lead to short-term increases in teacher performance, but they do not necessarily promote the deep, long-term engagement and high-quality teaching practices that drive significant improvements in student outcomes (Serin, 2018). Moreover, when extrinsic rewards are the primary motivators, they might inadvertently shift the focus from student learning to achieving specific performance targets, potentially neglecting broader educational goals (Deci et al., 1999).

In conclusion, although both intrinsic motivation and extrinsic motivation are important, the literature suggests that intrinsic motivation is generally more closely associated with creating the conditions for higher student achievement. This is because it promotes a more profound and sustainable commitment to professional growth in general and to teaching quality in particular, a positive classroom climate, and a willingness to adopt innovative teaching practices. These elements collectively contribute to improved student outcomes, showcasing that although both intrinsic motivation and extrinsic motivation have roles within educational frameworks, it is the intrinsic motivation that stands as a cornerstone for achieving higher student achievement.

Teacher Salary in Rwanda

In a Cabinet meeting held on July 29, 2022, which focused on enhancing teacher welfare and improving the educational quality in public and government-supported general and TVET schools, the Ministry of Education (MINEDUC, 2022) announced a notable salary increment for teachers. Specifically, secondary school teachers saw their salaries increase by 40%, effective from August 2022. This move, as articulated by Prime Minister Edouard Ngirente, aimed to bolster teacher welfare, to retain educators, and to elevate the standard of education (The New Times, 2023b). Highlighting the challenges faced by the education sector, Prime Minister Ngirente noted that approximately 1,000 teachers leave the profession monthly due to inadequate compensation. Furthermore, he mentioned that the government annually invests approximately Rwf1.2 billion in recruiting new teachers to fill these vacancies. The anticipated outcome of the salary enhancement, according to the Prime Minister, was to reduce teacher turnover in public schools and to enrich educational quality (The New Times, 2023a). Prime Minister Ngirente emphasized the government's objective, stating, "That's what we want as the Government, to ensure that a teacher provides education while they are secure and have an income which enables them to provide for themselves and their family."

In comments to The New Times, Stephanié Mukangango, General Secretary of the National Union of Teachers in Rwanda, praised the salary increase, indicating it as evidence of the government's commitment to education and its aspirations for high-quality education, adding, "now a teacher is happy" (The New Times, 2023b). This sentiment of happiness among teachers, crucially, has been linked to increased motivation among secondary school educators, as explored in the research by Bagherpour and Khadijeh (2016), underscoring the significant impact of well-being on teacher motivation.

The uniform salary increases for teachers from August 2022 served as a common extrinsic motivator just before the onset of the 2022-2023 school year. This universal extrinsic incentive complicates the analysis of its impact due to its indiscriminate application across all teachers. Given the existing body of research suggesting that extrinsic motivators do not necessarily promote the deep, long-term engagement and high-quality teaching practices that drive significant improvements in student outcomes (Serin, 2018), the researchers in the present study opted to focus on the role of intrinsic motivation, rather than extrinsic motivation, within the Rwandan secondary school setting.

External Constraints of Intrinsic Motivation

Intrinsic motivation, particularly in the context of secondary school teachers, is foundational to understanding what internally drives teachers to engage in their work with enthusiasm and dedication. However, solely focusing on intrinsic motivation might not provide a comprehensive understanding of the complex dynamics that influence teachers' intrinsic motivation levels. That is, intrinsic motivation, per se, does not wholly encapsulate the complex, multifaceted nature of teacher motivation. In fact, teachers operate within broader systemic, institutional, and sociocultural contexts that exert significant influence over their motivational states. Hence, environmental and situational factors, or the *external constraints of intrinsic motivation*, might play a crucial role in either facilitating or impeding this motivation. Unlike intrinsic motivation, which is fueled by personal interest, enjoyment, or inherent satisfaction, external constraints can deter or diminish this motivation by imposing limitations or pressures that can impede, diminish, or reshape their natural inclination to engage in teaching activities for the inherent satisfaction and joy derived from these activities. Indeed, these constraints significantly affect the expression and durability of intrinsic motivation by acting as *moderators* (i.e., factors that can weaken or strengthen the relationship between intrinsic motivation and its outcomes) or *mediators* (i.e., factors that serve as a bridge or intermediary that explains the process by which intrinsic motivation leads to certain outcomes). These constraints alter the manifestation of internal drives, thereby influencing teacher behaviors and attitudes.

External constraints often are rooted in the environmental, organizational, and systemic aspects of the educational setting and can significantly influence a teacher's ability to remain intrinsically motivated. Environmental constraints include inadequate teaching materials, insufficient classroom resources, and poor working conditions. Such limitations can hinder teachers' ability to implement innovative teaching strategies or to provide high-quality education, impacting their intrinsic satisfaction (Collie et al., 2012; Skaalvik & Skaalvik, 2018). Organizational constraints include policies, administrative decisions, excessive paperwork, rigid curricular requirements, and lack of professional autonomy within the school system that restrict teachers' creativity, flexibility, and ability to engage with students based on their interests and needs (Ingersoll & Merrill, 2010; Mee & Haverback, 2014). Systemic constraints include broader factors, such as standardized testing requirements, changing educational standards, societal expectations of teachers, and limited funding for education. These constraints can place additional pressure on teachers, limiting their ability to focus on intrinsically rewarding aspects of teaching (Berliner, 2011; Emler et al., 2019).

Although there is some overlap among environmental, organizational, and systemic constraints, the key difference lies in the scope and source of these constraints. Systemic constraints are broad and encompassing, derived from outside the immediate educational setting (e.g., larger education system, societal norms, government policies) and often beyond the direct control of individual schools. In contrast, organizational constraints are specific to the institution's policies and practices that can influence teacher autonomy and satisfaction (e.g., administrative demands, rigid curriculum guidelines, the school's leadership style). Meanwhile, environmental constraints are localized physical and material conditions that directly impact the teaching and learning environment (e.g., availability and quality of teaching resources, class size).

Purpose of Study

It is likely that, of these three levels of constraints (i.e., environmental, organizational, and systemic constraints), environmental constraints are the most straightforward to address in impacting intrinsic motivation because of their tangibility and specificity (e.g., inadequate classroom resources, poor working conditions, or outdated technology), localized control and decision-making that often fall within the purview of the school administration, and (potential) immediacy of impact on teacher motivation. Therefore, the researchers in this study chose exclusively to examine the environmental-based external constraints on intrinsic motivation, in conjunction with intrinsic motivation itself, particularly given the limited understanding of how these factors concurrently predict student achievement. Specifically, the purpose of the current research study was to examine the extent to which the intrinsic motivation levels and environmental-based external constraints of intrinsic motivation of secondary school teachers in Rwanda are related to the achievement levels of their students in mathematics.

As noted previously, the relationship between motivation and student achievement often has been trivial or even non-existent (cf. Bardach et al., 2021). Therefore, as concluded by Bardach et al. (2021), the link between teacher motivation and student outcomes needs closer examination, as does the link between environmental-based external constraints of intrinsic motivation and student outcomes. More specifically, given the limited research on the dynamics within Rwandan secondary schools, especially concerning the association between teachers' intrinsic motivation levels and students' mathematics achievement, it was hoped that the present study would contribute novel insights to the understanding of teacher motivation in Rwanda.

Theoretical Framework

The hypothesis in the current study that Rwandan both intrinsic motivation levels and environmental-based external constraints on intrinsic motivation of secondary school teachers predict students' mathematics achievement was driven by Self-Determination Theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2017, 2019, 2022; Ryan et al., 2019). SDT was developed in the 1970s and 1980s, primarily through the work of psychologists Richard M. Ryan and Edward L. Deci. This theory was initially conceived from studies focusing on intrinsic motivation and has since evolved to encompass a broad framework for the study of human motivation and personality. Since the 1980s (cf. Deci & Ryan, 1985), SDT formally articulated its concepts and applications across various domains, including the field of education.

SDT posits that human motivation is driven by a need for growth and fulfillment of three basic psychological needs: autonomy, competence, and relatedness. Autonomy refers to the need to feel in control of one's own behaviors and goals. Competence involves feeling effective and capable of achieving desired outcomes. Finally, relatedness denotes the desire to feel connected to others and to have a sense of belonging within social contexts. SDT differentiates between intrinsic motivation, which arises from within an individual due to interest or enjoyment in the task itself, and extrinsic motivation, which is driven by external incentives or pressures. The theory emphasizes that fulfilling the three basic psychological needs is particularly essential for fostering intrinsic motivation and overall well-being.

SDT also served as a theoretical framework to understand the impact of environmental-based external constraints on the intrinsic motivation of secondary school teachers. When teachers' basic psychological needs for autonomy, competence, and relatedness are thwarted by external constraints, intrinsic motivation can decrease, leading to diminished satisfaction and engagement (Niemiec & Ryan, 2009; Ryan & Deci, 2000b). More specifically, teachers' sense of autonomy can be undermined by environmental-based external constraints, such as inadequate resources or restrictive policies, by limiting teachers' choices and control over their teaching methods, thereby affecting their intrinsic motivation (Skaalvik & Skaalvik, 2018). Furthermore, environmental-based external constraints, such as poor classroom conditions or lack of access to necessary teaching materials, can hinder teachers' ability to deliver lessons effectively, reducing their sense of competence and, hence, intrinsic motivation. Also, environmental-based external constraints that isolate teachers or create adversarial relationships with students or administration can impair this sense of connection, impacting teachers' level of intrinsic motivation.

Method

Participants

Participants were 91 Secondary 3 mathematics teachers and their 2,828 Secondary 3 students, yielding a panel sample because repeated measures were collected for both teachers (i.e., two measures of intrinsic motivation) and students (i.e., pretest and posttest achievement scores). In Rwanda, a Secondary 3 teacher is a teacher responsible for instructing students who are in their third year of secondary education (S3). At this level, teachers usually are focused on completing the curriculum designed for the Ordinary Level (O-Level) cycle and preparing students for the more specialized subjects that they will choose in the Advanced Level (A-Level) cycle, which covers the last 3 years (S4 to S6) of secondary education.

With regard to the 91 teacher participants, the majority (80.2%) were men. Their ages ranged from 23 to 62 (*M* = 35.23, *SD* = 7.98), with 22.0% being in their 20s, 54.9% in their 30s, 16.5% in their 40s, 5.5% in their 50s, and 1.1% in their 60s. Further, the teachers' years of teaching ranged from 1 to 34 years (*M* = 9.80, *SD* = 7.26), with approximately one-half (52.7%) of the teachers having 9 years or less teaching experience. All but four of the STEM teachers had secured the attainment of either an undergraduate (i.e., Bachelor's) degree (57.1%) or an Advanced Diploma in Education (38.5%) qualification.

With regard to the Secondary 3 students, the majority were girls (60.3%). The ages of all students ranged from 11 to 20 (*M* = 16.14, *SD* = 1.44). In terms of the distribution of these students across the teacher participants, the number of students per teacher ranged from 10 to 49 (*M* = 31.50, *SD* = 7.86).

Instruments and Procedure

The teacher panel sample was administered a survey that contained two measures related to intrinsic motivation both at the start of the 2022 school year (i.e., November 2022) and at the end of the school year (i.e., May 2023). This administration took place face-to-face. The development of the two intrinsic motivation-based scales utilized in this study drew significant inspiration from the insights obtained during 18 focus group discussions (FGDs) conducted in Rwanda, which explored the perceptions of quality teaching in Rwandan secondary schools (Carter, Onwuegbuzie, et al., 2021a, 2021b). Additionally, the development of these scales was influenced by other resources, including existing research from low- and lower-middle-income countries and survey tools primarily used in the Global North, such as the Trends in International Mathematics and Science Study (TIMSS) Teacher Questionnaire (IEA TIMSS and PIRLS International Study Center, 2019) and the Teaching and Learning International Survey (TALIS; Organisation for Economic Co-operation and Development, 2018), which have seen international application with secondary school students and in teaching STEM [Science, Technology, Engineering, and Mathematics] subjects.

In order to score-validate the intrinsic motivation-based measure, a principal components analysis (PCA) was applied to the original 12 Likert-format items. The objective of this PCA was to examine the measure's underlying structure to ascertain the presence of subscales, their quantity, and the item composition of each subscale. Essentially, the PCA was conducted to clarify whether the derived scale was unidimensional, encompassing a singular thematic domain without any subscales, or multidimensional, indicative of encompassing multiple thematic areas or subscales. Prior to the PCA, all items were oriented to reflect a certain degree of agreement.

The PCA process involved grouping items into the same scale or subscale based on their statistical relationships: items were combined if they demonstrated statistical dependency among themselves while remaining statistically distinct from other items in the measure. A unidimensional scale would emerge if all items with significant factor coefficients (i.e., > .3; Lambert & Durand, 1975) were interrelated. Conversely, the emergence of two or more subscales would be indicated if sets of significant items formed distinct statistical relationships among themselves. This analytical approach resulted in the delineation of two distinct intrinsic motivation-based scales, as follows:

Teaching Profession Motivation Subscale (containing 7 items)

This subscale, presented in a 5-point Likert scale format, evaluates the extent of a teacher's intrinsic motivation concerning their general teaching practice and the teaching profession at large. It consists of the following seven items:

- I am proud of the work I do
- My work inspires me
- I am enthusiastic about my job
- The reality of teaching is better than I expected
- I think that the teaching profession is valued in society
- I am satisfied with opportunities for promotion available to me at my school
- I would leave my job as a teacher if there was an opportunity to work in another profession/field

Environmental-Based External Constraints of Intrinsic Motivation Subscale (containing 5 items)

This subscale, utilizing a 5-point Likert scale, assesses the degree to which a teacher experiences external constraints of intrinsic motivation in relation to their daily classroom teaching activities. It comprises the following five items:

- I need more time to prepare for class
- I have too much material to cover in class
- I need more time to assist individual students
- There are too many students in the classes I teach
- I have difficulty keeping up with all the changes in the curriculum

From these outlined items, it is evident that the two-teacher intrinsic motivation-based subscales vary in their focus areas. The Teaching Profession Motivation Subscale addresses broader motivational elements linked to the overarching teaching career. Conversely, the Environmental-Based External Constraints of Intrinsic Motivation Subscale is specific, targeting potential constraints directly connected to the routine, day-to-day aspects of classroom instruction. For instance, whereas the first item of the Teaching Profession Motivation Subscale concerns the teacher's overall perception of their role in teaching, the initial item of the Environmental-Based External Constraints of Intrinsic Motivation Subscale centers on the teachers' views about their preparation time for daily teaching activities. Nonetheless, a commonality shared by both subscales is their emphasis on intrinsic motivational factors over extrinsic ones, highlighting their importance in shaping both the core and the practical execution of teaching, thereby enriching psychological well-being and promoting professional attitudes.

The student panel sample underwent the Learning Achievements in Rwandan Schools (LARS) numeracy assessment, devised by the Rwanda Basic Education Board (REB). The 2022 version of this assessment was utilized, also known as LARS III. This numeracy evaluation comprised 31 multiple-choice items delivered through a paper-based questionnaire, such that the scores range from 0 to 31. LARS III serves as a critical instrument for gauging the effectiveness of numeracy education within Rwandan schools, providing valuable insights into student learning outcomes and areas in need of improvement. This assessment was administered twice: at the beginning (October-November 2022) and the end (May-June 2023) of the 2022-2023 academic year.

Research Design

The present study represented a *longitudinal multilevel study with a pretest-posttest design*—also more broadly known as a *longitudinal multilevel (i.e., hierarchical) panel study*—focusing on the effect of a teacher-level variable (intrinsic motivation) alongside other teacher-level variables (i.e., teachers' gender, age, years of teaching experience, type of school taught) in the presence of student-level variables (i.e., students' gender and age) on the change in student academic achievement over the course of a school year. This design was employed because it effectively captured the dynamics of educational processes, allowing for an investigation into how teacher intrinsic motivation influences student outcomes over time while accounting for the nested nature of educational data.

Analysis

Descriptive statistics were used to analyse the responses to each measure. In particular, scale means and standard deviations were computed. Also, a dependent samples *t-test* was used to compare scores generated by the two intrinsic motivation measures. Also, descriptive statistics were used to analyse the LARS III achievement scores.

Two sets of hierarchical linear modeling (HLM) analyses were conducted: the first at the beginning of the school year (i.e., pretest phase) and the second at the end of the school year (i.e., posttest phase). A notably distinctive aspect of this study was the utilization of HLM at the start of the school year for the purpose of *descriptive modeling*. Descriptive modeling, in essence, concerns efficiently summarizing or illustrating the structure of the data, without relying on an underlying causal theory, as one might in explanatory modeling. Furthermore, unlike predictive modeling, the objective here is not to forecast future outcomes. In this context, an HLM is considered descriptive when it serves to delineate the relationships between dependent and independent variables, rather than aiming for prediction or for establishing causality (cf. Shmueli, 2010).

For the pretest phase, two hierarchical linear models were employed. The initial model, commonly known as the null or unconditional two-level model, was designed to partition the variance of the outcome variable (i.e., student achievement) into two categories: variance that occurs between groups and variance that occurs within groups. This division was facilitated through the calculation of the intra-class correlation (ICC). The subsequent model introduced two variables at the group level (i.e., teacher level), namely, Level 2—specifically, measures of intrinsic motivation related to the teaching profession and external constraints. These teacher-level factors were analyzed to explore their relationship with student achievement. Notably, this model did not incorporate any variables at the student level (i.e., Level 1). Given the lack of predefined hypotheses regarding differences among teachers (i.e., group-classroom differences) concerning the significance of the two teacher-level variables, a random-slope model was not employed. Therefore, in the analysis, the slopes for the two teacher-level variables were treated as fixed rather than as variable. For both hierarchical linear models, full maximum likelihood estimation was used.

For the posttest phase, in addition to the null or unconditional two-level model, four HLM models were tested. The first (non-null) model, Model 1, consisted of three student-level main effect variables (i.e., Level 1), namely, student's age, student's gender, and student's pretest mathematics achievement (the covariate), and six group-level main effect variables (i.e., Level 2), namely, teacher's gender, teacher's age, teacher's years of experience, external constraints of intrinsic motivation, teaching profession motivation, and type of school. Model 2 contained the same three Level 1 main effect variables (i.e., student's age, student's gender, and student's pretest mathematics achievement) and six Level 2 variables, comprising the same five Level 2 main effect variables (i.e., teacher's gender, teacher's age, teacher's years of experience, external constraints of intrinsic motivation, teaching profession motivation) and the additional main effect variable of type of school. Model 3 contained the same three Level 1 main effect variables (i.e., student's age, student's gender, and student's pretest mathematics achievement) and eight Level 2 variables, comprising the same six Level 2 main effect variables as in Model 2 (i.e., teacher's gender, teacher's age, teacher's years of experience, external constraints of intrinsic motivation, teaching profession motivation, type of school) and two interaction effects, namely, between type of school and external constraints of intrinsic motivation, and between type of school and teaching profession motivation. Finally, Model 4 contained the same three Level 1 main effect variables (i.e., student's age, student's gender, and student's pretest mathematics achievement) and 10 Level 2 variables, comprising the same six Level 2 main effect variables as in Model 2 and Model 3 (i.e., teacher's gender, teacher's age, teacher's years of experience, external constraints of intrinsic motivation, teaching profession motivation, type of school), the same two 2-way interaction effects (i.e., type of school x external constraints of intrinsic motivation, type of school x teaching profession motivation), and two 2-way cross-level interaction effects (i.e., interactions between variables at different levels of analysis), namely, student's gender x external constraints of intrinsic motivation and student's gender x teaching profession motivation. Therefore, Model 1 was nested within Model 2, which, in turn, was nested within Model 3, which, in turn, was nested within Model 4. This nesting facilitated the direct comparison of HLM models. As was the case at the pretest phase, for all hierarchical linear models, full maximum likelihood estimation was used.

For the posttest phase, all Level 1 and Level 2 variables were fixed effect variables. In particular, random effects were not used for the Level 2 variables, especially the two intrinsic motivation-based variables (i.e., external constraints of intrinsic motivation, teaching profession motivation), for several reasons. First, because the present study represents a panel data analysis with repeated observations for the same individuals over time, the random effects assumption is very unlikely to hold (Clark et al., 2010). Second, although the random effects approach is preferable in scenarios when the selection mechanism is well understood and the researcher has access to rich data both for its efficiency over the fixed effects approach, as well as its use of shrunken residuals and its ability to model differential school effectiveness, in the present study, there was not sufficient knowledge about the process underlying the selection of students into mathematics classrooms and, even more importantly, it was not possible to adjust for the effects of selection—thereby justifying a fixed effects approach (Clark et al., 2010).

Another decision made was whether to use the mathematics gain scores (i.e., end-of-year mathematics achievement scores – beginning-of-year mathematics achievement scores) as the dependent variable or to use end-of-year mathematics achievement as the dependent variable, with the beginning-of-year mathematics achievement serving as a covariate. The decision was made to undertake the latter because including beginning-of-year scores as a covariate effectively controls for initial differences among the Rwandan secondary school students, thereby allowing for a more accurate assessment of the effect of intrinsic motivation on the end-of-year scores (Cronbach & Furby, 1970). Also, this approach is statistically more efficient and offers more power to detect the effects of interest because it accounts for the baseline variance in the outcome, reducing the error variance in the model (Allison, 1990).

In terms of the sample size justification for using HLM, for both the pretest and posttest phases, the 91 panel teachers greatly exceeds the recommended minimum sample of 50 participants per group for Level 2 variables (Moineddin et al., 2007). Further, the mean number of students per teacher of 31.50 is consistent with the recommended minimum number of 30 units for Level-2 variables (see, e.g., Hox, 1998; Maas & Hox, 2004, 2005). Therefore, an HLM analysis was justified using teachers as the Level-2 variable (Bell et al., 2014).

In order to assess the fit of each of the models and to compare these different models, as recommended by many HLM methodologist (e.g., Raudenbush & Bryk, 2002), multiple fit indices were used. Specifically, the following three fit statistics were computed: the -2 Log Likelihood (-2LL) deviance statistic, the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC). The -2LL statistic is a measure of the discrepancy between the observed data and the values predicted by the model. Lower values indicate a better fit because they signify that the model's predicted values are closer to the actual observed values. AIC is derived from the -2LL but includes a penalty for the number of parameters in the model to discourage overfitting. The model with the lowest AIC is considered better because it balances good fit with simplicity. Finally, similar to AIC, the BIC also originates from the -2LL and includes a penalty for the number of parameters. However, BIC imposes a heavier penalty for model complexity. The model with the lowest BIC value among a group of models is considered the best fitting model because it is deemed to offer the best trade-off between fitting the data well and keeping the model relatively simple (i.e., using fewer parameters).

Results

Descriptive Analysis

Panel Teachers

Table 1 presents the means and standard deviations of two measures of intrinsic motivation at the beginning and end of the school year. As can be seen from the statistically non-significant differences between the pretest and posttest means in this table, both external constraints of intrinsic motivation and teaching profession motivation were relatively stable during the course of the school year. However, interestingly, levels of teaching profession motivation were statistically significantly higher than were levels of external constraints of intrinsic motivation at both the beginning of the school year ($t = 5.26$, $p < .001$) and the end of the school year ($t = 4.69$, $p < .001$). Using Cohen's (1998) *d* criteria, the effect sizes associated with the observed differences between these two intrinsic motivation-based variables at both points in time were determined to be of a moderate magnitude, with effect sizes of 0.55 (95% confidence interval [CI] = 0.33, 0.77) at the beginning and 0.49 (95% CI = 0.27, 0.71) at the end of the school year. Therefore, the level of motivation towards the teaching profession was consistently and moderately higher than was the level of external constraints of intrinsic motivation over the course of the school year. This suggests that their level of intrinsic motivation was relatively high despite the constraints that they experienced.

Table 1

Means and Standard Deviations of Two Measures of Intrinsic Motivation at the Beginning and End of the School Year

	Pretest		Posttest		Difference			
Measure of Motivation	*M*	*SD*	*M*	*SD*	*M*	*SD*	*t* value	*p* value
External constraints of intrinsic motivation	3.75	0.70	3.82	0.63	0.07	0.66	1.00	.32
Teaching profession	4.18	0.45	4.17	0.50	-0.01	0.42	0.25	.81

Panel Students

Table 2 presents the means and standard deviations of LARS III achievement at the beginning and end of the school year. This table indicates that students experienced an increase in their mathematics achievement by 2.40 points by the end of the school year, corresponding to a 7.74% improvement in their performance. The effect size pertaining to this increase, as measured via Cohen's *d*, was 0.55 (95% CI = 0.51, 0.59), indicating a moderate level of growth in mathematics achievement.

Table 2

Means and Standard Deviations of LARS III Achievement at the Beginning and End of the School Year

	Pretest		Posttest		Difference			
Achievement	*M*	*SD*	*M*	*SD*	*M*	*SD*	*t* value	*p* value
LARS III	14.04	5.19	16.44	5.68	2.40	4.35	29.28	< .001

Hierarchical Linear Modeling

Pretest Phase

Unconditional Model. The dataset contains 2,828 secondary school students whose mathematics achievement scores were nested within 91 mathematics teachers. As Table 2 indicates, at the beginning of the school year, mathematics achievement had a mean of 14.04 (*SD* = 5.19) for the whole sample; however, the mean mathematics achievement varied across these 91 teachers, from 8.40 to 23.06, and the standard deviation for mathematics achievement ranged from 2.03 to 6.20. Therefore, the unconditional model (i.e., null model) helped to answer the question as to whether there was sufficient variability at the beginning of the school year within and/or between the panel teachers in the mean mathematics achievement that might justify explaining this variability.

Based on the intra-class correlation (ICC) of .382, the unconditional/null model, indicated that 61.8% of the variance in mathematics achievement occurred at the student level and 38.2% of the variance occurred at the group (i.e., teacher) level. This means that slightly more than one half of the differences in mathematics achievement exists at the student level. In turn, this means that the between-teacher differences were large (i.e., 38.2%) compared to within-teacher differences. This size of the between-teacher differences more than justifies the use of hierarchical linear modelling. Indeed, the ICC of .382 is much larger than the .02 suggested by Kreft and de Leeuw (1998) for using hierarchical linear modelling (see also Von Secker, 2002). Ignoring this very high intraclass correlation and analysing disaggregated data using traditional multiple regression techniques instead of hierarchical linear modelling could have resulted in an underestimation of the relationship between student achievement and teachers' levels of intrinsic motivation stemming.

The unconditional/null model revealed statistically significant variability in the mathematics achievement measure, thereby justifying examination of a conditional model (i.e., involving teachers' levels of intrinsic and extrinsic motivators) that could potentially explain some of this variability. As can be seen in Table 3, there was statistically significant variability both among teachers and within teachers. This table presents the estimates of the variance components associated with the fixed effects and random effects.

Table 3

Unconditional Model for Mathematics Achievement at the Beginning of the School Year

			95% Confidence Interval		
Effect	Estimate	Standard Error	Wald *Z*	Lower Bound	Upper Bound
Fixed effects:					
Intercept	13.86	0.34		13.18	14.55
Random Effects:					
Between-teacher variance	10.33	1.62	6.38*	7.59	14.04
Within-teacher variance	16.55	0.45	37.17*	15.70	17.45

* $p < .001$

Level 2 Model. Table 4 reveals that the Level 2 model indicated that neither of the two group-level (i.e., teacher-level) variables—namely, classroom teaching motivation and teaching professor motivation—were related to mathematics achievement. This model explained only 0.3% of the variance in mathematics achievement, which represents a negligible amount of variance explained (see Table 4). These findings suggest that, at the start of the school year, students with the highest scores were not unevenly distributed among mathematics teachers, regardless of whether those teachers had the highest or lowest motivation levels. Likewise, students with the lowest scores were not unevenly being taught by teachers based on the highest or lowest motivation levels in either of the two motivation categories. These findings provide compelling and robust evidence that, regardless of aptitude, the allocation of students across varying levels of motivation of the mathematics teachers was diverse. This heterogeneity in student distribution with respect to student aptitude across different motivational contexts of teachers underscores justifies the use of HLM analysis to examine the relationship between teacher motivation and gains in student achievement at the end of the school year.

Table 4

Relating Mathematics Achievement to Teacher Intrinsic Motivation at the Beginning of the School Year: Results from Hierarchical Linear Modelling

Model Predictor	Unstandardized regression coefficient	Standard error	*p* value
Group (i.e., Teacher level):			
Intrinsic motivators:			
External constraints of intrinsic motivation	-0.78	0.51	.13
Teaching profession motivation	-0.19	0.79	.81
R^2 group level	.01		
AIC	16143.84		
BIC	16155.72		
Deviance statistic	16139.84		

R^2 = amount of explained variance; AIC = Akaike's Information Criterion; BIC = Schwarz's Bayesian Criterion; Deviance statistic = -2 Log Likelihood

Posttest Phase

Unconditional Model. As Table 2 indicates, at the end of the school year, mathematics achievement had a mean of 16.44 (*SD* = 5.68) for the whole sample; however, the mean mathematics achievement varied across these 91 teachers, from 11.42 to 25.42, and the standard deviation for mathematics achievement ranged from 2.75 to 6.53. Therefore, the unconditional/null model that there was sufficient variability at the end of the school year within and/or between the panel teachers in the mean mathematics achievement to justify explaining this variability.

It can be seen from Table 5 that all three student-level (Level 1) variables—namely, student's age, gender, and pretest mathematics achievement (used as a covariate)—were statistically significant across all four models. This consistency underscores their importance as predictors of mathematics achievement.

At Level 2, teacher's gender, age, and years of experience were not statistically significant in any of the models, suggesting they have minimal impact on mathematics achievement. However, the type of school demonstrated statistical significance in Models 2 through 4, where it was included, highlighting its potential influence. Notably, none of the two-way interactions examined in Models 3 and 4 were statistically significant, suggesting that the main effects of the predictors do not vary significantly across different conditions and that a simpler model excluding these interactions might be more effective. This approach could enhance model parsimony, making it easier to interpret and potentially increasing the power to detect statistically significant main effects. Indeed, the teaching profession motivation variable, which was not statistically significant in the more complex Models 3 and 4 that contained interactions, emerged as a statistically significant predictor in the simpler Models 1 and 2 that did not contain any interactions.

Consistent with the elimination of Model 3 and Model 4 as viable models due to their statistically non-significant interactions, as can be seen in Table 5, all three fit indices (i.e., -2LL, AIC, BIC) were the lowest for Model 2. In this model, both intrinsic motivation-based variables (i.e., external constraints of intrinsic motivation, teaching profession motivation) were statistically significant. The comparison of deviance statistics between Model 2 and Model 1—which incorporates the three student-level variables at Level 1 and the two intrinsic motivation-based variables at Level 2—demonstrated that Model 2 provided a statistically significantly better fit than did the simpler nested Model 1. These findings provide justification for the selection of Model 2 as the model that provided the best trade-off between the goodness of fit and model simplicity (i.e., using fewer parameters).

The selected Model 2 reveals that, with respect to student-level variables, student's gender, student's age, and student's pretest mathematics achievement predict end-of-year mathematics achievement. Boys (b = 0.92, p < .001), younger students (b = -0.39, p < .001), and students with the highest levels of pretest mathematics achievement (b = 0.62, p < .001) were statistically significantly more likely to have the highest levels of end-of-year mathematics achievement. With respect to the teacher-level variables, schools of excellence (b = 2.39, p < 0.001) were statistically significantly more likely to have the highest levels of end-of-year mathematics achievement. However, of most interest for the purpose of the current study was what Model 2 revealed about the two teacher intrinsic motivation-based variables. Specifically, teachers with the least external constraints of intrinsic motivation (b = -0.47, p < 0.05) and those with the highest levels of intrinsic motivation associated with the teaching profession as a whole (b = 1.06, p < 0.05) were statistically significantly associated with better student outcomes in mathematics at the end of the school year. Examining the R^2 values reveals that 32.96% of the variance in end-of-year mathematics achievement was explained by the Level 1 predictors (i.e., student's gender, student's age, pretest mathematics achievement), whereas 86.97% of the variance was explained by the Level 2 predictors (i.e., primarily intrinsic motivation levels, environmental-based external constraints of intrinsic motivation, and schools of excellence).

Table 5

Unstandardised Regression Coefficients and Standard Errors: End of School Year LARS III Achievement

Model Predictor	Model 1	Model 2	Model 3	Model 4

Intercept	7.19** (0.30)	4.55** (0.52)	4.60** (0.52)	4.60** (0.52)
Student Level 1:				
Gender	0.92** (0.15)	0.92** (0.15)	0.92** (0.15)	0.91** (0.15)
Age	-0.40** (0.06)	-0.39** (0.06)	-0.39** (0.06)	-0.39** (0.06)
Beginning-of-Year Achievement	0.63** (0.02)	0.62** (0.02)	0.61** (0.02)	0.61** (0.02)
Teacher (i.e., Group) Level 2:				
Gender	_	-0.34 (0.39)	-0.33 (0.39)	-0.33 (0.39)
Age	_	-0.04 (0.05)	-0.03 (0.05)	-0.03 (0.05)
Years of experience	_	-0.04 (0.05)	-0.04 (0.05)	-0.04 (0.05)
External constraints of intrinsic motivation	-0.65* (0.25)	-0.47* (0.22)	-0.09 (0.68)	-0.06 (0.69)
Teaching profession motivation	1.21* (0.39)	1.06* (0.34)	0.30 (1.03)	0.36 (1.04)
Type of school	_	2.39** (0.39)	2.34** (0.40)	2.34** (0.40)
Level 1 x Level 2 Interactions				
Student Gender X ECIM	_	_		0.11 (0.24)
Student Gender X TPM	_	_		-0.17 (0.35)
Type of School X ECIM	_	_	-0.44 (0.50)	-0.46 (0.50)
Type of School X TPM	_	_	0.60 (0.76)	0.61 (0.76)
Variance Explained				
ICC	_	_	_	
R^2 student level	32.87%	32.96%	32.94%	32.90%
R^2 teacher (i.e., group) level	80.41%	86.97%	86.84%	86.84%
Model Fit				
Number of parameters	8	12	14	16
AIC	15554.42	15530.30	15527.35	15528.24
BIC	15566.29	15542.17	15539.22	15540.11
Deviance statistic	15550.42	15526.30	15523.35	15524.24
X^2 (df) Comparison of deviance statistics: vs. Model 0	1399.80** (5)	1423.92** (9)	1426.87** (11)	1425.98** (13)
X^2 (df) Comparison of deviance statistics: vs. Model 1	_	24.12** (4)	27.07** (6)	26.18** (8)
X^2 (df) Comparison of deviance statistics: vs. Model 2	_	31.93** (1)	2.95 (2)	2.06 (4)
X^2 (df) Comparison of deviance statistics: vs. Model 3	_	_		N/A

ECIM = External Constraints of Intrinsic Motivation: TPM = Teaching Profession Motivation
ICC = Intra-class correlation
R^2 = % of explained variance; Deviance statistic = -2 Log Likelihood; AIC = Akaike's Information Criterion; BIC = Schwarz's Bayesian Criterion
N/A = Deviance statistic is larger than for the comparison nested model.
**p < 0.001; *p < 0.05; The selected model is bolded.

Discussion

The present study distinguishes itself in the academic landscape through four notable contributions. Firstly, it emerges as one of a limited number of investigations focusing on teacher motivation within the Rwandan secondary school setting, marking a significant addition to the field. Secondly, it is among an even more select group of studies that delve into the intricate dynamics between teacher motivation and student achievement in Rwanda, offering fresh insights into this critical relationship. Thirdly, a comprehensive review of the existing literature indicates that this research likely is pioneering in applying HLM analytical techniques to explore the relationship between teacher motivation and student performance. Finally, the present study involves an examination of the relationship between teacher motivation and student achievement not only at the conclusion of the school year but also at the outset, revealing a heterogeneous distribution of students based on aptitude across distinct motivational levels established by teachers. This early identification of heterogeneity in student placement according to aptitude in various motivational teaching contexts at the beginning of the year affirms the rationale and methodological rigor of employing HLM to explore this complex relationship. This comprehensive approach enhances our understanding of how motivational dynamics between teachers and students evolve over the academic year, thereby solidifying the study's contribution to educational research methodologies. Further, this methodological approach not only underscores the study's innovative character but also enhances the depth and accuracy of the findings, potentially setting a new standard for future research in this area.

The results of the current study provide nuanced insights into the relationship among teacher intrinsic motivation, environmental-based external constraints on intrinsic motivation, and student mathematics achievement in Rwandan secondary schools. These findings are noteworthy because they add to the sparse literature on teacher motivation in the Rwandan educational context and its impact on student outcomes.

The lack of statistically significant interactions in the hierarchical linear models suggests that the effect of the teacher intrinsic motivation and environmental-based external constraints on intrinsic motivation on end-of-year mathematics achievement does not vary by the moderating variables or across different groups in the model. This implies a level of uniformity in how these variables interact across the context of the study, which simplifies the generalizability of the findings.

The literature review highlighted a complex and inconsistent relationship between teacher motivation and student outcomes (Bardach & Klassen, 2021). This study supports those findings to some extent. Specifically, it was found that although intrinsic motivation related to the teaching profession as a whole was associated with higher student mathematics achievement, external constraints of intrinsic motivation also yielded a statistically significant but negative relationship with student outcomes. These two findings, in combination, suggest that although intrinsic motivation can enhance student learning, external constraints can undermine these benefits, which aligns with studies by Nwakasi and Cummins (2018) that emphasized the detrimental effects of such constraints on teachers' job satisfaction.

Contrary to expectations set by previous literature suggesting minimal or inconsistent impacts of teacher motivation on student achievement (Bardach et al., 2021), the present study led to the identification of specific aspects of motivation that are directly linked to student performance. This could be due to the focus on intrinsic motivational factors and their direct relationship with classroom practices, which are more likely to influence student engagement and learning than are extrinsic motivational factors (Ryan & Deci, 2000a, 2000b; Serin, 2018). Furthermore, the findings regarding environmental-based constraints suggest that factors such as preparation time and class size, which often are overlooked, can have substantial impacts on teaching motivation and, hence, student achievement. This supports the arguments by Collie et al. (2012) and Skaalvik and Skaalvik (2018) that improving environmental conditions can enhance teacher motivation and, therefore, student outcomes.

The present findings have important implications for educational policy and practice in Rwanda. The significant impact of intrinsic motivation underscores the need for policies that nurture this aspect of teacher psychology, possibly through professional development and support systems that enhance autonomy and competence. Consistent with this assertion, Aimable and Cyprien (2022) recommended the following: The government should increase teachers' motivation by giving them an opportunity for continuous professional development (CPD) because it increases teachers' confidence in their daily work of teaching and learning and Teachers' salaries should be increased as the study indicated that it is not sufficient when you compare it with the prices at the markets" (p. 1). Further, Esdras and Andala (2021) recommended that "school authorities and educational officials have to keep motivating teachers in one way or another in order to get required performance." (p. 2). At the same time, addressing environmental constraints through better resource allocation, smaller class sizes, and more manageable curricula could remove barriers to effective teaching, thereby indirectly boosting student achievement. Moreover, addressing these constraints require targeted strategies at different levels, including policy reform for systemic constraints, investment in resources for environmental constraints, and organizational change for institutional constraints.

References

Aimable, N., & Cyprien, S. (March, 2022). Teacher personnel management and learning effectiveness in Rwandan primary schools: a case of Burera District [Rwanda]. *Personnel Management and Learning Effectiveness, 10*(4), 1-12.

Akhtar, S. N., Iqbal, M., & Tatlah, I. A. (2017, August). *Bulletin of Education and Research, 39*(2), 19-29.

Allison, P. D. (1990). Change scores as dependent variables in regression analysis. *Sociological Methodology, 20*, 93-114. https://doi.org/10.2307/271083

Bagherpour, M., & Khadijeh, K. (2016). The relationship between happiness and mindfulness with job motivation of teachers. *Journal of Educational Psychology, 7*(4), 39-49.

Bardach, L., & Klassen, R. M. (2021). Teacher motivation and student outcomes: Searching for the signal. *Educational Psychologist, 56*(4), 283–297. https://doi.org/10.1080/00461520.2021.1991799

Bardach, L., Klassen, R. M., & Perry, N. E. (2021). Teachers' psychological characteristics: Do they matter for teacher effectiveness, teachers' well-being, retention, and interpersonal relations? An integrative review. *Educational Psychology Review*. Advance online publication. https://doi.org/10.1007/s10648-021-09614-9

Bell, B. A., Morgan, G. B., Schoeneberger, J. A., Kromrey, J. D., & Ferron, J. M. (2014). How low can you go? An investigation of the influence of sample size and model complexity on point and interval estimates in two-level linear models. *Methodology, 10,* 1-11. https://doi.org/10.1027/1614-2241/a000062

Bennell, P., & Ntagaramba, J. (2008). *Teacher motivation and incentives in Rwanda: A situational analysis and recommended priority actions*. Rwanda Education NGO Cooperation Platform.

Berliner, D. C. (2011). Rational responses to high stakes testing: The case of curriculum narrowing and the harm that follows. *Cambridge Journal of Education, 41*(3), 287-302. https://doi.org/10.1080/0305764X.2011.607151

Butler, R. (2007). Teachers' achievement goals and associations with teachers' help seeking: Examination of a novel approach to teacher motivation. *Journal of Educational Psychology, 99*(2), 241–252. https://doi.org/10.1037/0022-0663.99.2.241

Byukusenge, V., Ntahomvukiye, C., & Paradie Nimusabe, R. (2022). Investigating the motivational strategies used by headteachers to motivate teachers in public secondary schools in Nyamagabe district of Rwanda. *Rwandan Journal of Education, 6*(1).

Calkins, L., Wiens, P., Parker, J., & Tschinkel, R. (2023). Teacher motivation and self-efficacy: How do specific motivations for entering teaching relate to teacher self-efficacy? *Journal of Education*. https://doi.org/10.1177/00220574221142300

Carter, E., Hategeka, K. B., & Singal, N. (2022). Head teacher and government officials' perceptions of teaching quality in secondary education in Rwanda. *Educational Management Administration & Leadership*. https://doi.org/10.1177/17411432221130587

Carter, E., Onwuegbuzie, A., Singal, N., & van der Velde, L. (2021a, April). What makes a 'good teacher' and constitutes 'quality teaching': Practitioner perspectives from Rwandan secondary schools. Leaders in Teaching Research and Policy Series, April 2021. Laterite, Rwanda and REAL Centre, University of Cambridge.

https://www.educ.cam.ac.uk/centres/real/publications/What%20makes%20a%20good%20teacher%20and%20constitutes%20quality%20teaching.pdf

Carter, E., Onwuegbuzie, A. J., Singal, N., & van der Velde, L. (2021b). Perceptions of teaching quality in Rwandan secondary schools: A contextual analysis. *International Journal of Educational Research, 109*. https://doi.org/10.1016/j.ijer.2021.101843

Christian, D., & Sayed, Y. (2023). Teacher motivation to teach in challenging school contexts on the Cape Flats, Western Cape, South Africa. *Education Sciences, 13*, 165. https://doi.org/10.3390/educsci13020165

Clark, P., Crawford, C., Steele, F., & Vignoles, A. (June 2010). *The choice between fixed and random effects models: Some considerations for educational research*. Working Paper No. 10/240. The Centre for Market and Public Organisation.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum.

Collie, R. J., Shapka, J. D., & Perry, N. E. (2012). School climate and social-emotional learning: Predicting teacher stress, job satisfaction, and teaching efficacy. *Journal of Educational Psychology, 104*(4), 1189-1204. https://doi.org/10.1037/a0029356

Cronbach, L. J., & Furby, L. (1970). How we should measure "change": Or should we? *Psychological Bulletin, 74*(1), 68-80. https://doi.org/10.1037/h0029382

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin, 125*(6), 627–668. https://doi.org/10.1037/0033-2909.125.6.627

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Plenum.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Emler, T. E., Zhao, Y., Deng, J., Yin, D., & Wang, Y. (2019). Side effects of large-scale assessments in education. *ECNU Review of Education, 2*(3), 279-296. https://doi.org/10.1177/2096531119878964

Esdras, R., & Andala, H. O. (2021). The influence of motivation on teacher performance in boarding secondary schools of the Western Province of Rwanda. *Journal of Education, 4*(1), 1-18.

Fidan, T., & Oztürk, I. (2015). The relationship of the creativity of public and private school teachers to their intrinsic motivation and the school climate for innovation. Procedia - Social and Behavioral Sciences, 195, 905–914. https://doi.org/10.1016/j.sbspro.2015.06.370

Gatsinzi, P., Jesse, R., & Makewa, N. P. (2014). Work and school related variables in teacher motivation in Gasabo District, Rwanda. *Journal of Education and Training, 1*(2), 262-275. https://doi.org/10.5296/jet.v1i2.4747

Han, J., & Yin, H. (2016). Teacher motivation: Definition, research development and implications for teachers. Cogent Education, 3, 1-18. http://dx.doi.org/10.1080/2331186X.2016.1217819

Hennessey, B. A. (2015). If I were Secretary of Education: A focus on intrinsic motivation and creativity in the classroom. *Psychology of Aesthetics, Creativity, and the Arts, 9*(2), 187–192. https://doi.org/10.1037/aca0000012

Herzberg, F., Maunser, B., & Snyderman, B. (1959). *The motivation to work*. Wiley.

Heystek, J., & Terhoven, R. (2015) Motivation as critical factor for teacher development in contextually challenging underperforming schools in South Africa. *Professional Development in Education, 41*(4), 624-639, https://doi.org/10.1080/19415257.2014.940628

Hilmi, A., Ali, C., & Nihal, C. (2016). Herzberg's motivation-hygiene theory applied to high school teachers in Turkey. *European Journal of Multidisciplinary Studies, 1*(4), 90-97. https://doi.org/10.26417/ejms.v1i4.p90-97

Howard, J. L., Jane, X. Y., & Bureau, J. (2020). The tripartite model of intrinsic motivation in education: A 30-year retrospective and meta-analysis. *Journal of Personality. 88*, 1268–1285. https://doi.org/10.1111/jopy.12570

Hox, J. J. (1998). Multilevel modeling: When and why. In I. Balderjahn, R. Mathar, & M. Schader (Eds.), *Classification, data analysis, and data highways* (pp. 147-154). Springer.

IEA TIMSS and PIRLS International Study Center. (2019). *Performance at international benchmarks*. https://timss2019.org/wp-content/uploads/frameworks/T19-Assessment-Frameworks.pdf

Ingersoll, R., & Merrill, L. (2010). Who's teaching our children? *Educational Leadership, 67*(8), 14–20.

Jang, H., Reeve, J., & Deci, E. L. (2010). Engaging students in learning activities: It is not autonomy support or structure but autonomy support and structure. *Journal of Educational Psychology, 102*(3), 588–600. https://doi.org/10.1037/a0019682

Janke, S., Bardach, L., Oczlon, S., & Lùftenegger, M. (2019). Enhancing feasibility when measuring teachers' motivation: A brief scale for teachers' achievement goal orientations. *Teaching and Teacher Education, 83*, 1–11. https://doi.org/10.1016/j.tate.2019.04.003

Kagema, J. (2018). The school curriculum and its influence on teacher motivation in curriculum implementation in Kenya. *Journal of Culture and Values in Education, 1*(1), 9-25. https://www.learntechlib.org/p/210567/

Kreft, I., & de Leeuw, J. (1998). *Introduction to multilevel modeling*. Sage.

Kunter, M. (2013). Motivation as an aspect of professional competence: Research findings on teacher enthusiasm. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), Cognitive activation in the mathematics classroom and professional competence of teachers: Results from the COACTIV project (pp. 273–289). Springer.

Lambert, Z. V., & Durand, R. M. (1975). Some precautions in using canonical analysis. *Journal of Market Research, 12*, 468–475. https://doi.org/10.1177/002224377501200411

Lauermann, F. (2017). Teacher motivation, responsibility, pedagogical knowledge and professionalism: A new era for research. In S. Guerriero (Ed.), *Pedagogical knowledge and the changing nature of the teaching profession* (pp. 171–191). OECD Publishing.

Liu, S., & Onwuegbuzie, A. J. (2014). Teachers' motivation of entering the teaching profession and their job satisfaction: A cross-cultural comparison of China and other countries. *Learning Environments Research, 17*, 75-94. https://doi.org/10.1007/s10984-013-9155-5

Maas, C. J. M., & Hox, J. J. (2004). Robustness issues in multilevel regression analysis. *Statistica Neerlandica, 58*, 127-137. https://doi.org/10.1046/j.0039-0402.2003.00252.x

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology, 1*, 86-92. https://doi.org/10.1027/1614-2241.1.3.86

Mee, M., & Haverback, H. R. (2014). Commitment, preparation, and early career frustrations: Examining future attrition of middle school teachers. *American Secondary Education*, 39-51.

Ministry of Education. (2018). *Report from quality education enhancement awareness campaign (phase III) and other school inspections*. Kigali: Author.

Ministry of Education. (2022, August 1). *Communique on the raise of salary for primary and secondary schools teachers*. Kigali: Author. https://www.mineduc.gov.rw/news-detail/communique-on-the-increment-of-salary-for-primary-and-secondary-schools-teachers

Moineddin, R., Matheson, F. I., & Glazier, R. H. (2007). A simulation study of sample size for multilevel logistic regression models. *BMS Medical Research Methodology, 7*, 1-10. https://doi.org/10.1186/1471-2288-7-34

Monaco, T. (2016). *Improving the recruitment and retention of teachers in rural Rwanda*. Master's Thesis, Duke University. https://pdfs.semanticscholar.org/4811/ceb5f6e210e3a2e1da6afe460d01d434c41c.pdf

Muvunyi, E. (2016). *Teacher motivation and incentives in Rwanda: Analysis of stakeholders' perceptions of the changes in teachers' motivation during 2008-13*. Doctoral thesis. University of Sussex.

Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education, 7*(2), 133-144. https://doi.org/10.1177/1477878509104318

Nizeyimana, G., Nzabalirwa, W., Mukingambeho, D., & Nkiliye, I. (2021). Hindrances to quality of basic education in Rwanda. *Rwandan Journal of Education, 5*(1), 53-67.

Nwakasi, C. C., & Cummins, P. A. (2018). Teacher motivation and job satisfaction: A case study of North West Nigeria. *Global Journal of Educational Research, 17*, 103-112. https://doi.org/10.4314/gjedr.v17i2.2

Nyamagabe district (2020). *Report on public secondary schools*. Nyamagabe: District direction of education.

Organisation for Economic Co-operation and Development. (2018). *TALIS 2018 technical report*. OECD Publishing. https://www.oecd.org/education/talis/TALIS_2018_Technical_Report.pdf

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Sage.

Richardson, P. W., Karabenick, S. A., & Watt, H. M. G. (2014). *Teacher motivation: Theory and practice*. Routledge/Taylor and Francis.

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford.

Ryan, R. M., & Deci, E. L. (2019). Brick by brick: The origins, development, and future of self-determination theory. In A. J. Elliot (Ed.), *Advances in motivation science* (Vol. 6, pp. 111–156). Elsevier.

Ryan, R. M., & Deci, E. L. (2000a). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*(1), 54–67. https://doi.org/10.1006/ceps.1999.1020

Ryan, R. M., & Deci, E. L. (2000b). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68–78. https://doi.org/10.1037//0003-066X.55.1.68

Ryan, R. M., & Deci, E.L. (2022). Self-determination theory. In F. Maggino (Eds.), *Encyclopedia of quality of life and well-being research*. Cham. https://doi.org/10.1007/978-3-319-69909-7_2630-2

Ryan, R. M., Ryan, W. S., Di Domenico, S. I., & Deci, E. L. (2019). The nature and the conditions of human autonomy and flourishing: Self-determination theory and basic psychological needs. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (2nd ed., pp. 89–110). Oxford University Press.

Save the Children (2011). *Teacher motivation: Theoretical framework, situation analysis of Save the Children country offices, and recommended strategies*. Country offices: Save the Children.

Serin, H. (2018) The use of extrinsic and intrinsic motivations to enhance student achievement in educational settings. *International Journal of Social Sciences & Educational Studies, 5*(1), 191-194. https://doi.org/10.23918/ijsses.v5i1p191

Shmueli, G. (2010). To explain or to predict? *Statistical Science, 25*(3), 289–310. https://doi.org/10.1214/10-STS330

Skaalvik, E. M., & Skaalvik, S. (2018). Job demands and job resources as predictors of teacher motivation and well-being. *Social Psychology of Education, 21*(5), 1251-1275. https://doi.org/10.1007/s11218-018-9464-8Butler, R. (2007). Teachers' achievement goals and associations with teachers' help seeking: Examination of a novel approach to teacher motivation. *Journal of Educational Psychology, 99*(2), 241–252. https://doi.org/10.1037/0022-0663.99.2.241

The New Times. (2023a, May 03). *Education ministry sheds light on teachers' pay rise*. https://www.newtimes.co.rw/article/201713/News/education-ministry-sheds-light-on-teachersa-pay-rise

The New Times. (2023b, May 03). *Pay rise for teachers will boost retention–Ngirente*. https://www.newtimes.co.rw/article/201706/News/pay-rise-for-teachers-will-boost-retention-angirente

Von Secker, C. (2002). Effects of inquiry-based teacher practices on science excellence and equity. *Journal of Educational Research, 95*, 151–160. https://doi.org/10.1080/00220670209596585

Watt, H. M. G., & Richardson, P. W. (2007). Motivational factors influencing teaching as a career choice: Development and validation of the FIT-Choice scale. *The Journal of Experimental Education, 75*(3), 167–202. https://doi.org/10.3200/JEXE.75.3.167-202