

The role of openness to experience in innovating teaching and instruction through leader-member exchange and teacher creativity

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ABSTRACT

Despite a multitude of studies in organizational behavior research invested in understanding the interrelationship among personality traits, leader-member relationship (LMX), creativity, and innovative behaviors over the past decades, these concepts have not attracted much attention in education. The present research concerned how innovative teaching can be enhanced through teacher openness to experience, creativity and LMX. More specifically, we examined the relationship between teacher openness to experience and teachers' implementation of innovative teaching ideas through mediating and moderating roles of LMX and teacher creativity. Employing a stratified sampling strategy, the data was collected from 3016 teachers nested within 148 schools across different regions in Malaysia. A latent moderated mediation analysis was utilized to test ten hypotheses. Results showed that teachers' openness to experience was a significant predictor of their creativity, the quality of their relationship with the school leader (LMX) and innovative teaching practices. A significant and indirect relationship between openness and the implementations of innovations in the classroom was also evident through the mediating roles of creativity and LMX. However, we found no evidence for the moderating role of LMX and creativity in the effect of both openness and creativity on the implementation of innovations. We conclude that creating space for teachers that support willingness for new experiences could help establishing better relationships with principals, which together could enhance the development and implementation of creative ideas in classrooms that might address issues with and enhance student learning.

1. Introduction

In today's rapidly evolving education landscape, innovation and creativity in teaching help schools maintain their competitive advantage and have become increasingly important in enhancing student outcomes (Mascareño et al., 2020). However, researchers asserted that initiating and sustaining innovation in schools are challenging endeavors partly due to the persistent fixed structures and routines that resist change (Zhao, 2020). Unlike other sectors where innovation might be driven by market forces or corporate strategy,

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individual teacher innovation is influenced by unique external factors such as technological advancements, changing workforce demands (Valdés Sánchez & Gutiérrez-Esteban, 2023), policy changes, and diverse student needs, including those of special education students (Adams et al., 2024). These external pressures necessitate a distinct approach to fostering creativity among teachers. Notably, teachers are the driving force behind innovations in schools. They are best positioned to implement creativity in the classroom to enhance student learning (Zhou & George, 2001; Žydzūnaitė & Arce, 2021). Therefore, it is crucial to understand what stimulates teachers to contribute to innovation.

In cultures characterized by high power distance and hierarchical structures, teachers often work within a highly regulated framework, where curricula and educational outcomes are predetermined, thus constraining their creative autonomy (Bellibaş & Kılınc, 2023). These contextual factors distinguish the fostering of creativity and innovation in teaching from other professional environments. Consequently, this scenario necessitates unique leadership approaches designed to support and enhance teachers' creativity (Adams & Periasamy, 2024; Bauer & Erdogan, 2015; Feng & Adams, 2023). Moreover, the relationship between leaders and their teachers plays a crucial role in effectively navigating these complexities, underscoring the importance of dynamic and supportive leadership in educational settings (Bauer & Erdogan, 2015; Feng & Adams, 2023; Hughes et al., 2018). Specifically, teachers and principals develop a unique relationship through work-related interactions where both parties 'assess' and understand what to expect. The leader-member exchange (LMX) theory captures this aspect of leadership (Hammond et al., 2011; Omilion-Hodges & Ptacek, 2021). High-quality LMX relationships between principals and teachers are associated with increased innovative behavior (Karin et al., 2010; Mascareño et al., 2020; Özdemir, Çoban, Büyükgoze, Gümüş, & Pietsch, 2024; Shermuly et al., 2013) and enhanced creativity (Hammond et al., 2011; Hughes et al., 2018). Despite its importance, the relationship between LMX and creativity has received limited attention in education, with existing studies focusing primarily on business contexts. Moreover, existing findings are inconsistent. For example, Shermuly et al. (2013) found no significant direct association between LMX and innovative behaviors, whereas Karin et al. (2010), drawing on data from Dutch and German surveys, reported a positive and significant relationship. This inconsistency highlights variability across studies and underscores the need for more nuanced research to understand how LMX functions specifically within schools. The relationship between LMX, creativity, and innovation has been considered before in business administration studies (e.g. Mascareño et al., 2020; Smothers, 2023), but there is little evidence on how these concepts function within educational settings.

In addition, the influence of personality traits, especially teachers' openness to experience, on these dynamics remains underexplored. Teachers' personality traits, such as openness to experience, play a pivotal role in fostering innovation within schools. Traits like curiosity, imagination, and adaptability are highly valued, as teachers with high openness are more likely to engage positively with leaders and adopt creative practices (Phillips & Bedeian, 1994; Fairman & Mackenzie, 2015). Openness to experience is chosen over other traits such as extraversion due to its direct relevance to teacher cognitive flexibility, curiosity, and a willingness to embrace new ideas, qualities that are crucial for creativity and innovation (McCrae & Costa, 1997). Openness to experience has been linked to innovative behavior across diverse cultural contexts, enhancing both adaptability and intercultural sensitivity in classrooms (Cui et al., 2023). Teachers exhibiting this trait are more inclined to experiment with new teaching methods, pursue professional development, and implement innovative approaches tailored to their students' needs (Chiaburu et al., 2014; Leon, 2018). This trait enhances the efficacy of LMX by facilitating deeper interactions and mutual understanding between leaders and members, which is essential for fostering innovative behaviors (Fairman & Mackenzie, 2015; Teng et al., 2024). This aligns with findings that suggest positive engagement with leaders can significantly foster teacher creativity and innovation (Judge & Zapata, 2015; Raja & John, 2010). Teachers who feel supported and understood by their leaders are often more inclined to experiment with innovative teaching methods in the classroom (Chiaburu et al., 2014; Hammond et al., 2011; Teng et al., 2024). Despite its importance, research on how openness to experience influences teacher creativity and innovation in schools remains scarce, emphasizing the need for further exploration in this area.

With this research, we contribute to the leadership literature by expanding the knowledge gap about the role of LMX in fostering innovative teaching practices and teacher creativity, and by demonstrating the relevance of teacher openness to experience. Therefore, in the present study, we examine the interrelationships among teacher's openness to experience, leader-member exchange (LMX), teacher creativity, and the use of innovative teaching practices in schools. Beyond what has been investigated in the previous literature, this research takes a more holistic approach and scrutinizes the relationship between teacher openness and innovative instructions by considering the mediating and moderating roles of LMX and teacher creativity. In addition to theoretical contributions, this study will be valuable for policymakers and teacher training. Policymakers can use these findings in designing frameworks that strengthen LMX relationships and enhance teachers' creativity and innovation within a centralized education system in a Southeast Asian society. Teacher training programs can integrate strategies that cultivate teacher openness to experience, equipping educators with the adaptability and creativity needed for innovative teaching.

2. Theoretical background

This section will provide the theoretical background of each concept examined in the present study, followed by a section justifying the proposed associations among concepts. Our perspective, generally, is based on Schumpeter's theory of innovation (Schumpeter, 1943), which understands innovation as the creation of a novel idea or the transformation of existing knowledge into innovation, driven by the phenomenon of creative destruction. As a consequence, creativity is considered an essential prerequisite for the emergence of innovation (Stacey, 1996). In our study, this phenomenon is examined from the perspectives of personality psychology, which suggests that personality traits influence individual creativity and innovative capacity, and are linked to individual differences (Feist, 1998), as well as from the perspective of role and exchange theories, which propose that the quality of the dyadic relationship between a leader and a follower shapes individual behaviors and, consequently, follower outcomes (Graen & Uhl-Bien, 1995).

2.1. Openness to experience

Openness to experience is one of the least studied extensive five personality taxonomy (Bernierth et al., 2007), including conscientiousness, agreeableness, extraversion, and neuroticism (Xu et al., 2021). It refers to a personality trait described as a willingness to engage with new ideas and experiences (Soto & John, 2017) or a persistent need to enlarge experience (McCrae & Costa, 1997). People who are strong in this tend to be imaginative, curious, open-minded (Rammstedt et al., 2022), original, and intelligent (Goldberg, 1990). They can be contrasted with those who prefer routine, tradition, and regularity (Connelly et al., 2014). Open people are not passive recipients of experiences but seek new, multifaceted experiences (McCrae & Costa, 1997). These people can be characterized by three traits: aesthetic sensitivity, intellectual curiosity, and creative imagination (Rammstedt et al., 2018; Soto & John, 2017). Aesthetic sensitivity refers to someone with artistic emotions fascinated by arts, music, and literature. The term is closely related to cognitive intelligence (McCrae & Costa, 1997), and therefore, these individuals are intellectually curious and deep thinkers who persistently desire to learn, question, and explore new ideas and concepts. Such trait supports these individuals in transforming their basic cognitive abilities into knowledge acquisition (Rammstedt et al., 2018). Additionally, they have a creative imagination that enhances originality in their thoughts and helps them generate new and original ideas. (Soto & John, 2017). Open individuals are more intellectually curious and possess stronger motivation to engage in intellectual activities (Rammstedt et al., 2018). Individuals high in this trait are expected to establish a flexible and creative daily routine and adapt to new situational demands with interest and enthusiasm. (Rammstedt et al., 2022).

2.2. Leader-Member exchange (LMX)

Tracing back to the 1970s, many studies in organizational behavior research invested in understanding the concept of LMX and its consequences (Graen & Uhl-Bien, 1995). However, despite the growing interest in the topic over the decades, the concept has been relatively new within education (see Daniëls et al., 2020; Flores et al., 2020; Huang & Yin, 2024). The concept is linked to the social exchange theory, suggesting that the follower reacts to the leader based on how the leader treats that individual follower (Cropanzano et al., 2017), pointing to the reciprocity of relationships between two persons (Graen & Uhl-Bien, 1995). Consistently, in education, the concept often refers to the quality of the dyadic relationship between the school principal and the teacher (Daniëls et al., 2020; Flores et al., 2020; Huang & Yin, 2024).

LMX considers leadership the unique exchange of relationships between the leader and each employee (Erdogan & Liden, 2002). This relationship holds significant importance since an individual's relationship with his/her leader is considered a lens through which the entire work experience is viewed (Gerstner & Day, 1997). The quality of this relationship is likely to vary depending on the followers' characteristics (Yukl et al., 2009) and other factors, such as context (Somech & Wenderow, 2006). In addition, the nature of the relationship within one organization is also likely to differ among different individual followers (Sherony & Green, 2002). High LMX is an indication of a high-exchange relationship based on mutual trust and respect, loyalty, attention, and support (Erdogan & Liden, 2002), reinforcing an employee's extra-role behaviors (Ng, 2017) while an employee with low LMX is likely to follow only what is described in formal requirements, thus reinforcing transactional exchange (Liden & Graen, 1980). Researchers related the high-quality LMX relationships between principals and teachers to several outcomes and found that it positively affects teachers' commitment (Rahmy, 2018) and innovative work behaviors (Widiastuti & Kusmaryani, 2023).

2.3. Teacher creativity

Creativity has been essential for human survival and growth. Human beings would not have advanced to their current state without having it (Zhou & George, 2003). "Creativity in the workplace is defined as producing novel and useful ideas or solutions" (Zhou & George, 2003, p. 547). It is also considered a mental process to produce novel, useful/appropriate ideas (Klijin & Tomic, 2010). Both definitions indicate that ideas should be both novel and useful or appropriate to be defined as creative. This means that novel ideas without any useful aspect may not be creative (Zhou & George, 2003). Besides, the definition of creativity is not confined to generating novel ideas; the concept also involves the production of high-quality and original solutions to problems (Mumford et al., 2011). Considering the discussions around creativity, teacher creativity can be conceptualized as producing novel and useful teaching ideas and solutions to classroom problems to facilitate better student learning and achievement. Based on the conceptualization by Zhou and George (2001), creative teachers are typically expected to suggest new ways to increase the quality of tasks at hand and achieve goals and objectives. These teachers are more likely to seek new techniques, technologies, processes, and ideas during teaching and learning activities. They are not afraid to take risks by implementing new teaching strategies. They develop new ideas and creative solutions to educational and classroom problems.

2.4. Individual teacher innovation

Innovation is "a new or improved product or process (or a combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD/Eurostat, 2018). This definition highlights two dimensions of innovation (product or process) and two types of innovation (incremental or radical). Innovation could be defined as a product or a process. As a product, innovation is about introducing a new or improved version of a good, service, or program, yet as a process, it is defined as a new methodology for dealing with a task and achieving efficiency (Khan, 2018). As for the types of innovation, incremental innovations have to do with improvements, adaptations,

or extensions while at the same time keeping the fundamental essence of the product, process, or service, while radical innovations imply a significant change and departure from existing products, services or programs (Freixanet & Rialp, 2022). In educational settings, on the one hand, a school may introduce new or significantly different products and services, including new syllabi or textbooks, or new pedagogies; on the other hand, the school could change school processes to provide better educational goods or services (Vincent-Lancrin et al., 2019). Moreover, teachers can make slight improvements in their teaching practices while alternatively, they can change their teaching philosophy by implementing a more student-centered approach. While the first approach would fit with incremental innovation, the latter could be considered an example of radical innovation (Bellibaş, Ryskulueva, Levin, & Pietsch, 2024).

2.5. The present study

Fig. 1 shows the conceptual model guiding our research. While empirical evidence is not strong and somewhat contradictory. For example, Zadok et al. (2024) found a negative correlation between openness to experience and intellectual stimulation. They explained this by the argument that openness to experience focuses on personal growth and development, and this focus may divert the attention of the teacher-leader away from the needs of teachers. Supporting this, Bernerth et al. (2007) found a negative association between openness to experience and LMX relationship, suggesting that those more open to experience are less likely to have high-quality relationships with their leaders. This negative association may stem from several factors: open employees might feel that their creative and unconventional solutions are unrewarded by supervisors. Alternatively, the broad range of open employees' interests could divert focus from core tasks, reducing managerial trust. Another might be that supervisors consider these people non-conforming and rebellious, leading them to not give key work, promotions, and resources necessary for fostering high-quality relationships (Bernerth et al., 2007).

On the other hand, from a theoretical standpoint, researchers expect a positive association (Blau, 1964; Bernerth et al., 2007). Scholars suggest that open individuals are imaginative, curious, and open-minded (Rammstedt et al., 2022) and avoid routine and regularity (Connelly et al., 2014). Therefore, individuals highly open to experience tend to think innovatively, question established beliefs, and introduce new ideas and perspectives (Rammstedt et al., 2018). In the context of LMX, the dynamic exchange between employees and supervisors is likely to be enriched when both parties can challenge each other constructively. If a leader or subordinate perceives their counterpart as incapable of engaging in meaningful intellectual exchange or reciprocating at an equivalent level, they may be less inclined to invest in the relationship, trust the other party, or extend the professional respect that characterizes a high-quality LMX relationship (Bernerth et al., 2007). From this perspective, since open employees will be more open-minded, curious and creative, their leader will be willing to build a better relationship with them. We expect teachers open to new experiences will have a good relationship with their principal, and propose:

H1: *Openness to experience positively affects the perceptions of leader-member exchange (LMX).*

Among the five big personality domains, openness to experience is more consistently and strongly related to creativity (Silvia et al., 2009). Raja and John (2010) found that openness to experience is the only personality significantly associated with employee creativity. Open people are more motivated to expand their experiences and are more successful in jobs requiring creativity and innovation (Judge & Zapata, 2015). Open people are intellectually curious and strongly desire to seek new experiences and explore original ideas (Soto & John, 2017) and hence, these people are more creative (Jirásek & Sudzina, 2020).

While research has provided a well-established argument and strong evidence for the relationship between openness to experience and creativity within broader organizational research, little is known about how this relationship manifests in educational settings. In fact, only a few studies have specifically examined this connection. For example, Lee and Kemple (2014) found that teachers with higher levels of openness to experience had more engagement in creativity-related experiences, and those teachers were more likely to experiment with creativity-fostering teaching styles. However, since educational organizations are highly context-dependent, with relationships varying based on the specific system in which they operate, it is crucial to investigate this relationship across different educational contexts and settings (Hallinger, 2018). Doing so would help develop a more comprehensive and well-founded understanding of how openness to experience influences creativity in education. Therefore, we expect that:

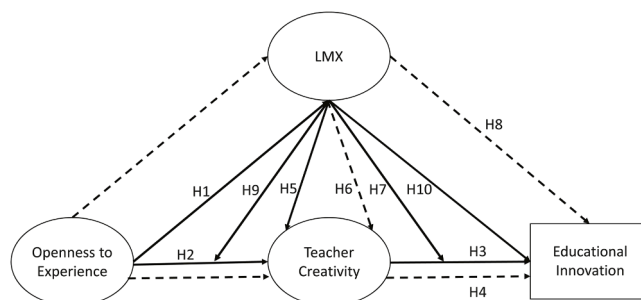


Fig. 1. Conceptual model of the study.

H2: *Openness to experience positively affects teacher creativity.*

Since these two concepts are related, we presume a strong correlation between creativity and innovation. They are often considered to have many overlapping aspects and tend to be confused (Ford, 1996). However, theoretical discussions around the concept helped us distinguish between the two concepts. While creativity implies generating new and useful ideas (Zhou & George, 2003), innovation is more related to implementing those ideas in practice (Styhre & Sundgren, 2005). From this perspective, creativity might be considered a cognitive process, while innovation is the actions derived from such cognitive activities. In other words, producing novel and useful ideas is only the initial stage of innovative behavior. The search to implement these ideas is also integral to innovative behavior (Schermuly et al., 2013). Creativity describes the development of something, while innovation may also include the transfer of a procedure, product, or process already in use elsewhere (Hammond et al., 2011). Creativity is a subset of innovation and is a necessary antecedent for (Woodman et al., 1993) or the cornerstone of innovation (Klijn & Tomic, 2010). With the production of new ideas (creativity), the development and implementation of activities that characterize innovation become possible (Mumford, Hester and Robledo, 2011).

In education, creative teachers think outside the box, defy conventional norms, and implement innovative steps to identify new ways of teaching and learning (Žydzūnaitė & Arce, 2021). Creativity provides teachers with the competence to develop contextually relevant and dynamic teaching materials, improving student comprehension and participation (Suwartono et al., 2022). Creative teachers are more prone to adopt constructivist teaching methods that enhance deeper student engagement and active learning (Ucus & Acar, 2018). Even in schools with limited resources, creative teachers can come up with innovative pedagogical strategies that address the unique learning needs of students (Leon, 2018). Therefore, we propose that

H3: *Teacher creativity positively affects teachers' use of innovative teaching practices.*

Considering H2 that openness will be positively related to creativity and H3 that creativity will be positively associated with innovation in teaching, an indirect hypothesis can also be proposed:

H4: *Openness to experience indirectly affects innovative teaching practices through teacher creativity*

LMX considers the dyadic relationship quality between the leader and the follower as an essential organizational feature to comprehend the leader's influence on people and the organization (Bauer & Erdogan, 2015). Researchers expect that LMX will also be positively associated with the creative behaviors of employees. LMX theory suggests that as the relationship between leaders and followers develops, both partners move from a formal relationship to a better-quality relationship characterized by mutual trust and respect (Hammond et al., 2011). The quality of relationship embedded in high LMX provides followers with a stronger sense of advocacy and liking from their leader, creating a certain level of comfort and trust necessary for taking risks and demonstrating creativity (Tierney et al., 1999). In addition, a high-quality LMX relationship offers the followers increased autonomy and decision-making opportunities, which is crucial for creativity (Hammond et al., 2011). While they may not directly implement creative ideas due to a good relationship, they will likely be motivated to generate useful and original ideas (Mascareño et al., 2020).

While research on the role of LMX in teacher creativity in an educational context is scarce, a positive association is highly likely based on theoretical work in organizational research. Supporting these theoretical assumptions, empirical education research has found that teachers in high LMX relationships with their principals are more likely to develop and implement creative ideas (Vermeulen et al., 2022; Widiastuti & Kusmaryani, 2023). However, Malaysia's cultural context, characterized by high power distance and collectivism (Adams & Periasamy, 2024), may influence the dynamics of LMX and creativity. In high power distance cultures, hierarchical structures are deeply respected, which may limit open exchanges between leaders and teachers (Adams & Tan, 2022). Teachers might be hesitant to propose innovative ideas out of fear of authority. These cultural nuances suggest that the positive effects of LMX on creativity observed in Western contexts may differ in Malaysia. We therefore hypothesize that:

H5: *LMX positively affects teacher creativity.*

Considering hypothesis 1 that openness to experience positively affects the perceptions of LMX and hypothesis 5 that LMX will be positively related to teacher creativity, an indirect hypothesis can be proposed:

H6: *Openness to experience indirectly affects teacher creativity through teacher perception of LMX.*

Due to the importance of innovative behaviors for organizational performance and effectiveness, researchers investigate various factors contributing to its improvement (Karin et al., 2010). Few researchers studied the leader-follower relationship as a critical factor in influencing innovative behaviors (e.g., Karin et al., 2010; Shermuly et al., 2013). According to a meta-analysis by Rosing et al. (2011), leadership approaches that imply a certain degree of fluidity and flexibility, i.e., LMX, can better describe the relationship between leadership and innovation than more static leadership models, i.e., transformational or shared leadership, and consequently only LMX leads "to a consistent relationship with followers' individual innovation" (Rosing et al., 2011, p. 965). On the one hand, some empirical research found no direct effect but rather an indirect one through creativity (Mascareño et al., 2020). Others focused specifically on education and found a positive association with some components of LMX only. For example, Widiastuti and Kusmaryani (2023) explored the influence of LMX on high school teachers' innovative work behavior and found that affection and

acknowledgment of contributions were positively related to innovation, with affection having the most decisive impact. Conversely, loyalty and professional respect were not associated with innovative behaviors. On the other hand, the theoretical works pointed to a potential positive direct relationship. For example, it is proposed that followers with high-quality relationships with the leader tend to spend more time on non-routine tasks. In comparison, individuals with lower-quality relationships are likely to devote more time to routine tasks (Liden & Graen, 1980). Non-routine tasks can support members in developing novel ideas as they face new challenges and experiences (Schermuly et al., 2013). In addition, those working on non-routine tasks are less restricted and more flexible and enjoy a greater sense of freedom (Vecchio & Gobdel, 1984), all of which provide more opportunities to generate and implement their ideas (Schermuly et al., 2013).

H7: LMX positively affects individual teachers' implementation of innovative teaching practices.

Considering hypothesis 1, that openness to experience positively affects the perceptions of LMX, and hypothesis 7, that LMX will be positively related to innovative teaching, an indirect hypothesis can be proposed:

H8: Openness to experience indirectly affects implementing innovative teaching practices through teacher perception of LMX and teacher creativity.

George and Zhou (2001) asserted that openness can lead to creativity under certain circumstances because some organizational conditions may not allow the creative potential of the employees to come to the surface. High-exchange relationships based on mutual trust and respect, loyalty, attention, and support (Erdogan & Liden, 2002), which reinforces employees' non-routine behaviors (Ng, 2017), may motivate employees to use new experiences, encouraging the development of creative ideas (George & Zhou, 2001). Whereas, in the case of low LMX, which is associated with less involvement in decision-making and autonomy, the employee may not feel sufficient support that could encourage them to take risks by generating novel perspectives (Tierney et al., 1999). In education, high-quality relationships between principals and teachers could support teachers' new experiences to be translated into creative ideas. We therefore propose that:

H9: LMX moderates the openness to experience and teacher creativity relation.

As indicated previously, creativity and innovation are two related concepts and those who possess creative ideas tend to implement innovation (Klijn & Tomic, 2010). However, scholars argued that the connection between creativity and implementation may not be as direct or consistently positive as expected. In fact, the relationship between creativity and the execution of ideas may be relatively weak or loosely connected (Baer, 2012). Since innovation is beyond the mere generation of ideas and requires action (Schermuly et al., 2013), certain conditions, i.e. skepticism, resistance, perceived usefulness, and uncertainty, might affect the motivation of employees with creative ideas to turn those new perspectives into actions (Baer, 2012). Baer (2012) suggests that networks and strong relationships can also play a significant role in the facilitation and implementation of creative ideas. In the present study, we used LMX as a factor that could possibly encourage employees to put their novel ideas into practice. Employees with high-quality LMX relationships with their leaders develop a greater sense of autonomy and perceive the work environment as safe for risk-taking. This means LMX creates conditions under which ideas are more feasible (Chiaburu et al., 2014). Such conditions could better support employees' creative ideas that lead to innovation (Mascareño et al., 2020). In schools, this means that high-quality relationships between principals and teachers can enhance school conditions that motivate creative teachers to take action and implement their ideas in the classroom.

H10: LMX moderates the teacher creativity and innovative practices relation.

3. Methods

This study was conducted using a correlational, cross-sectional, and moderate-mediation design.

3.1. Sample and data collection

The present study was conducted in Malaysia, a highly centralized education system. The Ministry of Education manages and regulates all aspects of education, such as curriculum designs, budgeting, and the appointment of teachers and school principals (Adams & Tan, 2022). School leaders in Malaysia are expected to be strong leaders with decision-making flexibilities accorded to them. This includes instructional leadership matters such as school improvement planning and curriculum, co-curricular planning, and budgeting of school funds (Harris et al., 2017), while teachers are executors of a fixed curriculum. The main of the Malaysian Education Blueprint 2013–2025 (Ministry of Education Malaysia, 2012) was to transform the nation's education system to meet international standards and make it more relevant to the needs of the 21st century. Notably, the blueprint set ambitious goals, such as positioning Malaysia within the top one-third of nations in global assessments like the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS).

A three-stage stratified random sampling procedure was adopted for this study from teachers working in schools. We first identified eight states in Malaysia's north, south, eastern, central, and western regions. Next, we identified schools by urbanity (urban vs. rural)

and school type (e.g., primary and secondary schools) within each states. Schools were then randomly selected within these strata to avoid selection bias. These efforts were taken to ensure the data was representative. In the final stage, teachers within the selected schools were invited to participate. The inclusion criteria required teachers to have at least one year of teaching experience to ensure they had sufficient familiarity with school operations and leadership dynamics. We then obtained permission from the Ministry of Education, Malaysia, to conduct the study and contacted the school principals. Principals were briefed on the study's objectives and procedures and were asked to facilitate the participation of their teaching staff. An invitation email containing a unique link to the online questionnaire was sent to each principal, who then distributed it to teachers within their schools. The online survey was hosted on a secure platform, ensuring data confidentiality. Participants accessed the survey via the provided link, which directed them to an introductory page detailing the study's purpose, voluntary participation, and confidentiality assurances. Teachers consented to participate by proceeding to the questionnaire.

The survey was open for a period of 15 weeks (February to May 2024). Teachers' busy schedules and workload pressures may have hindered their ability to complete the survey. To mitigate this challenge, we sent reminder emails bi-weekly to principals to encourage participation. Out of the 8736 teachers invited from 148 schools, 3016 teachers completed the survey, resulting in a response rate of 35 %. 83.2 % ($n = 2508$) of the respondents were women and 16.8 % ($n = 508$) were men. This reflects the gender distribution in Malaysia's teaching workforce, where women form the majority (OECD, 2019). 72.5 % ($n = 2187$) of the teachers were from urban schools compared to 27.5 % ($n = 829$) from rural schools. This figures are also consistent with Malaysia's urban-rural demographics, where urban populations and resources are more concentrated, enhancing the representativeness of the sample.

3.2. Data analyses

Given that our data originate from a single instrument, we initially examined the common variance by loading all items utilized in the analyses on a single unrotated factor (Harmann, 1960). If the value determined here is $< 50\%$, it is unlikely that method bias in model estimates due to common variance is to be expected (Lance et al., 2010). In our data, the common variance amounted to 42.4 %. To test our hypotheses, we applied latent moderated structural equation modelling (LM-SEM, Cheung et al., 2021) in *Mplus* 8.5, using least square mean and variance adjusted (WLSMV) estimator to account for potential skewness (Muthén & Muthén, 2017). The WLSMV estimator has been developed for use with categorical data where the assumptions of normality and continuity are not applicable (Carle, 2009). In *Mplus*, WLSMV is implemented with a probit link and has been shown to perform better with binary outcome and indicator variables compared to maximum likelihood estimators with robust standard errors (MLR; Beauducel & Herzberg, 2006; Suh, 2015).

In accordance with the recommendations set forth by Cheung (2024), our methodology was structured in four phases: 1. Estimation of the measurement models; 2. Estimation of the SEM without moderation; 3. Estimation of the SEM with moderation; 4. Determination of the significance of the indirect and moderating effects. As teachers were nested in schools, we further requested cluster-robust standard errors by specifying `TYPE = COMPLEX`. Hence, a sandwich estimator was employed to statistically correct standard errors for the nestedness of teachers in schools (Li, 2016). Without such an adjustment, standard errors of the regression coefficients would have been underestimated, resulting in an overestimation of the coefficients' significance (McNeish et al., 2017). To estimate random effects or, more precisely, to request estimates of random slopes (Cheung et al., 2021), we used the option `TYPE = RANDOM`.

In order to examine the convergent and discriminant validity of our model and model variables, we calculated the average variance extracted (AVE) of each latent construct (Fornell & Lacker, 1981). Convergent validity may be assumed if the AVE exceeds the threshold of 0.50 (Hair et al., 2010). Discriminant validity can be assessed by comparing every AVE with the correlation coefficients between pairs of variables (Fornell & Lacker, 1981). The AVE must exceed the common variance (i.e. the square of the correlations) of a given pair of variables (Farrell, 2010; Hair et al., 2010).

In estimating reliability coefficients, we have followed the best practice recommendations set out by Dunn et al. (2014) and Hayes and Coutts (2020) for the estimation of such coefficients in the context of structural equation modelling (SEM). Consequently, an alternative to Cronbach's alpha (α) was employed in the form of McDonald's omega (ω) to evaluate the reliability of the measurement instruments used.

To assess the goodness of fit of the primary path model, we used the standardized root mean square residual (SRMR) and the comparative fit index (CFI), with cut-offs of $SRMR < 0.08$ and $CFI > 0.90$ (Hu & Bentler, 1999). Because the root mean square error of approximation (RMSEA) is sensitive to the method used to estimate the model parameters and shows worse performance with ordinal indicators (Shi & Maydeu-Olivares, 2020), we did not use it to assess model fit. To evaluate indirect or mediated effects, we further tested the robustness of the mediation effects through bootstrapped mediation analysis that provides 95 % bias-corrected bootstrap confidence intervals with 1000 bootstrap replications (Hayes, 2018; Preacher & Hayes, 2008). Indirect effects are significant if the 95 % confidence intervals (CIs) do not include zero (Hayes, 2018). To investigate the relevance of independent and mediating variables in greater detail, we also calculated and reported Cohen's f^2 and Cohen's incremental f^2 (Fey et al., 2023) as effect sizes. According to Cohen (1988), (incremental) f^2 values of > 0.02 indicate small effects, > 0.15 indicates medium effects, and > 0.35 indicates large effects.

Concerning the evaluation of interaction effects, we followed the suggestion made by Maslowsky et al. (2015). Consequently, since no fit indices are available for random effects models in *MPLUS*, we compared the log-likelihoods of the model without and of the model with latent interactions to investigate if the addition of the LMX-interactions added significant value to the analysis, using a log-likelihood ratio test and report coefficient D (Klein & Moosbrugger, 2000). Further, we investigated whether more variance in both teacher creativity and the implementation of innovations in classrooms (ΔR^2) could be explained as a result of the addition of the LMX interaction parameters (Maslowsky et al., 2015).

3.3. Measures

Leader Member Exchange (LMX) ($\omega = 0.926$). For measuring LMX, we adapted Graen and Uhl-Bien's (1995) seven-item scale. As the standard tool for measuring leader-member exchange (Martin et al., 2016), there is extensive evidence of the high quality and validity of this scale in different contexts (Joseph et al., 2011) and across cultures (Rockstuhl et al., 2012). According to a meta-analysis by Rosing et al. (2011, p. 965), this measure is the only leadership style leading "to a consistent relationship with followers' individual innovation". This finding pertains to both individual creativity and innovation itself, whereby, according to a study by Tierney et al. (1999), the correlation with individual creativity ($r = 0.30$) is stronger than with the implementation of creative ideas in the workplace, that is, innovation performance ($r = 0.17$). Teachers were asked to assess their relationship with their principal by responding to seven items on a five-point Likert-type scale for each item. An example item is "How well does your principal understand your job problems and needs?", coded from 1 (Not a Bit) to 5 (A Great Deal). Another example item is "I have enough confidence in my principal that I would defend and justify his or her decision if he or she were not present to do so.", also coded from 1 (Strongly disagree) to 5 (Strongly agree).

Openness to Experience ($\omega = 0.894$). We adapted the OECD's Programme for the International Assessment of Adult Competencies (PIAAC, Rammstedt et al., 2024) approach to assess teachers' openness to experience. We therefore used the three-item (extra) short version of the Big Five Inventory (BFI-2-XS, Rammstedt et al., 2018; Soto & John, 2017) to assess the extent to which teachers are open-minded, curious and creative thinkers. Accordingly, the scale contains one item each from aesthetic sensitivity, creative imagination, and intellectual curiosity. This short form is considered to be highly valid, contextually stable and an appropriate screening tool for the openness dimension of the Big 5 (Rammstedt et al., 2018, 2024; Soto & John, 2017), with Rammstedt et al. (2018, p. 159) commenting that the instrument we use "offers considerable reliability and validity with minimal assessment time." As demonstrated in the meta-analysis by Karwowski and Lebeda (2016), this measure is the strongest personality trait predictor of individual creativity ($r = 0.48$), with higher correlations observed when creativity is self-rated and short(er) BFI scales are used. In relation to the implementation of creative ideas, i.e., innovation, Stock et al. (2016) demonstrate a similar phenomenon: The BFI openness to experience short scale shows the strongest correlation with innovation among the five BFI dimensions, with the correlation being stronger for idea generation than for the creation of a usable solution or the diffusion of innovation. This finding aligns with the meta-analysis by Hammond et al. (2011), which found that openness to experience is more strongly associated with the ideation phase than with the implementation phase in the individual innovation process. All items were answered on a 4-point Likert-type scale (1 = strongly disagree, 4 = strongly agree). An example item is "I see myself as someone who is original and comes up with new ideas."

Teacher Creativity ($\omega = 0.919$). We used three items developed by George and Zhou (2001) to capture the self-reported teacher creativity. This is the instrument used in most studies to measure individual creativity in the workplace (Anderson et al., 2014), and only one out of three measures are based on self-reports (Yuan et al., 2022). In this context, creativity is defined as a combination of novelty and usefulness (Zhou & Hoever, 2014). A significant body of research demonstrates the efficacy of the measuring instrument, particularly in terms of prognostic validity (Anderson et al., 2014; Yuan et al., 2022; Zhou & Hoever, 2014; Zhou & Shelley, 2024). Barth and Stadtmann's (2024) meta-analysis showed that no cultural bias can be identified in such creativity self-reporting scales. It is, however, widely acknowledged that the generation of ideas does not always lead to their implementation, and that the best ideas are not always selected for implementation (Baer, 2012; Rietzschel et al., 2010). Accordingly, using the scale developed by George and Zhou (2001), Škerlavaj et al. (2014) report a moderate correlation of $r = 0.34$ between individual creativity and employee innovation behavior. All items were answered on a 4-point Likert-type scale (1 = strongly disagree, 4 = strongly agree). An example item is "I exhibit creativity on the job when given the opportunity to".

Individual teacher innovation. To assess teachers' implementation of individual teacher innovations in the classroom, we followed Pietsch et al. (2024) and, thus, adapted items from the European Community Innovation Survey (CIS; Behrens et al., 2017), which is based on the Organisation for Economic Co-operation and Development's (OECD/Eurostat, 2018) Oslo Guidelines for the collection, reporting and use of data on innovation. In conducting the survey, we adhered to the guidelines outlined in the Copenhagen Manual for collecting innovations in the public sector, which guides the implementation of Innovation Barometer-type surveys (CO-PI, 2021). In order to achieve the objective of our study, questions Q5, Q6, Q7 and Q9 from the questionnaire presented in Appendix 2 of the manual have been adopted and adapted, with minor modifications made to align them with the specific requirements of the study. Hence, initially, teachers were shown the following information as an introduction:

We would now like to know from you if process innovations, i.e. innovations or changes affecting your pedagogical work that did not previously exist at your classroom, have been introduced in YOUR classroom in the last 12 months. Note: Process innovations include new or noticeably changed processes with regard to the educational work in your classroom (e.g., in teaching and instruction).

The subsequent assessment of the innovation outcome followed a three-step process: In a first step, teachers were asked whether they introduced innovations in pedagogical work, i.e., teaching and instruction, in their classrooms in the past 12 months, using a binary-coded item (0 = no, were not introduced, 1 = yes, were introduced). Specifically, the wording of this question was:

Have you introduced process innovations, i.e. innovations or noticeable changes that affect the pedagogical work in your classroom, in the last 12 months?

If teachers answered yes to this question, as a second step they were asked to indicate the most important innovation in the past 12 months, using a free-form field. The wording of the item was as follows:

What was the most important innovation in this area in the last 12 months?

Related to this statement, they then, in a third step, were required to rate how radical this innovation was for their classroom on a scale ranging from 1 (incremental innovation – improving and/or supplementing and/or adapting what already exists) to 10 (radical innovation – introducing something completely new). To adapt the scales for Malaysian teachers, we followed Hambleton and

Patsula's (1999) framework, using forward and backward translation from English to Malay language, expert reviews, and pilot testing to ensure both linguistic accuracy and alignment with the intended concepts.

For our analyses, we use the binary coded variable and thus investigate whether a teacher has implemented any process innovations in his or her classroom in the 12 months prior to the survey, i.e. innovations or changes that affect his or her pedagogical work and that did not exist there before.

4. Results

4.1. Descriptives and measurement models

The results of the descriptive statistics (mean, standard deviation, and correlations) are shown in Table 1. A total of 37 percent of the surveyed teachers reported having implemented individual teacher innovations in their classrooms over the 12 months preceding the survey. The innovations mentioned in the free-form fields were diverse and encompassed topics such as implementing peer learning and mentoring programs, the utilization of artificial intelligence (AI) for assessment and learning, and the implementation of programs to assist students in managing stress and enhancing their overall mental health.

In general, the teachers surveyed indicated that they were open to new experiences ($M = 3.21$, $SD = 0.54$) and acted creatively in their approach to their work ($M = 3.12$, $SD = 0.50$). The quality of the relationship with their principals was mixed ($M = 3.68$, $SD = 0.72$). All variables included in our model are significantly correlated with one another ($p < .05$). As expected, we find a particularly high correlation between openness to experience and teacher creativity ($r = 0.804$, $p < .05$). LMX is also linked to both openness to experience ($r = 0.337$, $p < .05$) and teacher creativity ($r = 0.319$, $p < .05$). Innovation showed a significant positive correlation ($p < .05$) with all other model variables. Teachers who implemented educational processes that did not previously exist in their classrooms exhibited a higher level of openness to experience ($r = 0.215$, $p < .05$), engaged in more creative actions ($r = 0.234$, $p < .05$), and had a more positive relationship with their principals than teachers ($r = 0.164$, $p < .05$) who did not implement any innovations in their classrooms over the 12 months preceding the survey.

The AVE measures for LMX, openness to experience and teacher creativity were, 0.643, 0.738, and 0.791, respectively. The AVE of all constructs was well above the relevant 0.50 threshold, indicating convergent validity. Furthermore, the squared correlation of each pair of constructs was considerably lower than their associated AVEs, supporting both discriminant validity between constructs and overall validity of the proposed conceptual model.

Since only three items were used to measure openness to experience and teacher creativity, fit indexes for these constructs are not reported here, as they will demonstrate a perfect model fit. The fit values for the LMX measurement model indicate a good model fit and are as follows: CFI = 0.970, SRMR = 0.031.

4.2. Structural equation model

We constructed a structural equation model to examine the interrelationships between a teacher's openness to experience, creativity at the job, the implementation of innovations in the classroom and perceived LMX (H1, H2, H3, H5, and H7). This model does not yet account for moderation effects and was estimated using the WLSMV estimator. The SEM demonstrated an acceptable fit to the data (CFI = 0.938, SRMR = 0.028). All coefficients are reported in Table 2. The standardized regression coefficients are as follows: Openness to Experience \rightarrow LMX ($\beta = 0.397$, $p < .000$), confirming H1; Openness to Experience \rightarrow Teacher Creativity ($\beta = 0.956$, $p < .000$), confirming H2; Teacher Creativity \rightarrow Innovation ($\beta = 0.271$, $p < .000$), confirming H3; LMX \rightarrow Teacher Creativity ($\beta = -0.013$, $p = .219$), rejecting H5; LMX \rightarrow Innovation ($\beta = 0.132$, $p < .000$), confirming H7. The model variables account for 90.4 percent of the explained variance in teacher creativity, for 15.7 percent of the explained variance in perceived LMX, and for 11.7 percent of the explained variance in individual teacher innovation. Concerning teacher creativity, Cohen's incremental f^2 is 8.03 for openness to experience and zero for LMX. Cohen's f^2 for openness to experience as a predictor of perceived LMX is 0.19. And, regarding individual teacher innovation incremental f^2 is 0.05 for teacher creativity and 0.02 for LMX. The findings indicate that openness to experience is a highly relevant predictor of teacher creativity (large effect), as well as for LMX (medium effect). Furthermore, the findings show that both teacher creativity and LMX are significant factors of implementing innovations in the classroom (small effects).

4.3. Mediation analysis

To investigate our hypotheses H4, H6 and H8, and, hence, the indirect effects of both a teacher's openness to experience and LMX on individual teacher innovation in the classroom, we re-estimated the structural equation model using a bootstrapping procedure with 1000 replications and calculated total indirect effects—that is, the sum of all indirect and partially indirect effects (Preacher &

Table 1
Means, standard deviations, correlations of latent and manifest variables.

	M	SD	LMX	Openness	Creativity	Innovation
LMX	3.68	.72	1			
Openness	3.21	.54	.337	1		
Creativity	3.12	.50	.319	.804	1	
Innovation	0.37	.48	.164	.215	.234	1

Note: Bold correlations $p < .05$.

Table 2
Direct, mediation and moderation effects.

Parameter	Estimate	95 % Confidence Intervals		p
		Lower	Upper	
<i>Direct effects</i>				
Openness to Experience -> LMX	.397			< .001
Openness to Experience -> Teacher Creativity	.956			< .001
Teacher Creativity -> Innovation	.271			< .001
LMX -> Teacher Creativity	-.013			>.100
LMX -> Innovation	.132			< .001
<i>Indirect effects</i>				
Teacher Creativity -> LMX -> Innovation	.053	.031	.077	<.001
Teacher Creativity -> Teacher Creativity -> Innovation	.258	.208	.304	<.001
LMX -> Teacher creativity -> Innovation	-.013	-.015	.003	>.100
Total Mediation Effect	.309	.265	.351	<.001
<i>Moderation effects</i>				
LMX*Openness to Experience -> Teacher Creativity	-.008			>.100
LMX*Teacher Creativity -> Innovation	-.140			>.100

Hayes, 2008). The analyses demonstrate a significant total indirect effect of a teacher's openness to experience ($\beta = 0.309$, 95 %CI [0.265, 0.351], $p < .001$) on the implementation of innovations in a teacher's classroom. This effect is comprised of two distinct partially indirect effects: one effect mediated via teacher creativity ($\beta = 0.258$, 95 %CI [0.208, 0.304], $p < .001$) and the other via LMX ($\beta = 0.053$, 95 %CI [0.031, 0.077], $p < .001$). These results suggest that we accept H4 and H6, respectively. Our data also indicate that there is no discernible indirect effect along the pathway from LMX to teacher creativity to individual teacher innovation ($\beta = -0.013$, 95 %CI [-0.015, 0.003], $p > .10$), leading us to reject H8. Concerning the more complex path from openness to experience via LMX to teacher creativity to individual teacher innovation; consequently, there is no indirect effect ($\beta = -0.002$, 95 %CI [-0.005, 0.001], $p > .10$) observable too.¹

4.4. Moderation analysis

Finally, to investigate our hypotheses H9 and H10, and hence, to test the moderation effects of LMX, we added two latent interaction terms using the XWITH statement and re-estimated the model as a complex random effects model. To receive standardized path coefficients, we, first, standardized all manifest indicator variables, following Maslowsky et al. (2015). The first interaction (H9) assumes that LMX may facilitate the openness to experience-teacher creativity relation. The second interaction (H10) suggests that LMX may amplify the effect of teacher creativity on individual teacher innovation.

Here, in the first step, we investigate moderation effects only. Both interaction coefficients are slightly negative and not statistically significant: LMX*Openness to Experience -> Teacher Creativity ($\beta = -0.008$, $p > .10$); LMX*Teacher Creativity -> Innovation ($\beta = -0.138$, $p > .10$). In the second step, we combined moderation and mediation and, thus, applied a moderated mediation model (Hayes, 2013; Preacher et al., 2007). The analyses show that both added coefficients are slightly negative and not statistically significant: LMX*Openness to Experience -> Teacher Creativity ($\beta = -0.008$, $p > .10$); LMX*Teacher Creativity -> Innovation ($\beta = -0.140$, $p > .10$), leading us to reject H9 and H10. All other path coefficients remain stable. Consequently, the log-likelihood ratio test showed that adding both parameters did not make a difference, as coefficient D was close to zero and not statistically significant ($D = \sim 0$, $p > .10$). Adding the newly created variables further did neither increase R^2 for teacher creativity ($\Delta R^2 = \sim 0$), nor for individual teacher innovation ($\Delta R^2 = \sim 0$).

¹ Because we discovered a relevant positive correlation between perceived LMX and teacher creativity when openness to experience was not controlled for, and because the relation between the two variables was slightly negative below zero in our SEM, we also examined possible multicollinearity or suppression effects by following Cheung and Lau (2008) and Preacher and Hayes (2008). However, the bootstrapped 95% confidence interval of the direct effect of LMX on teacher creativity included zero (95%CI [-.048, .013], $p > .10$). Consequently, no suppression effects were identified, indicating that no relationship between LMX and teacher creativity can be demonstrated in the data. Furthermore, the absence of this relationship cannot be attributed to the strong influence of the teacher's openness to experience.

In other words, LMX does not moderate the relationship between a teacher's openness to experience and their creativity, nor does it moderate the relationship between creativity and individual teacher innovation in the classroom. As previously demonstrated, both creativity and LMX exert a positive and distinct direct effect on individual teacher innovation in the classroom. These findings suggest that high-quality LMX relationships promote a certain level of individual teacher innovation in the classroom, regardless of the teacher's creativity, as the two variables are not confounded with one another and yield distinct effects.

5. Discussion

The present study aimed to examine the relationship between openness to experience and innovative teaching practices, including the mediation and moderation effects of LMX and teacher creativity, based on the multilevel analysis of the data collected from 3016 teachers in 148 schools across various regions of Malaysia. Our results indicated that openness to experience significantly relates to LMX and teacher creativity. This result provided supporting evidence that teachers' personality traits are essential in schools, as teachers who are open-minded, imaginative, and willing to explore new ideas are likely to engage positively with their leaders more often (Bernherth et al., 2007). Additionally, such openness fosters creativity, enabling teachers to design engaging lessons that enhance student learning (Fairman & Mackenzie, 2015; Judge & Zapata, 2015; Raja & John, 2010). Teachers with high levels of openness are more likely to experiment with novel teaching strategies, incorporate interdisciplinary approaches, and integrate technology to make learning more interactive and meaningful (Karwowski & Lebuda, 2016). Furthermore, the present study also showed that teacher creativity and LMX are significant factors of innovations in the classroom. When teachers receive encouragement and resources from their leaders, they are more likely to explore innovative teaching practices in their classrooms (Chiaburu et al., 2014; Hammond et al., 2011). In addition, creative teachers excel in the development of novel ideas. Therefore, supporting teacher creativity is crucial for continuous individual teacher innovation (Schermuly et al., 2013; Zhou & George, 2003).

The main finding of this study is that teachers' openness to experience could play a critical role in enhancing the effect of individual teacher innovation in the classroom. This effect is mediated by two distinct factors: teacher creativity and LMX (Graen & Uhl-Bien, 1995; McCrae & Costa, 1997). However, our findings also indicate teacher creativity and LMX are important in their own right and also act as indirect pathways for the effect of openness to experience on individual teacher innovation. This underscores the critical role of strong, supportive relationships with their leaders in fostering teacher creativity (Da'as, 2023; Judge & Zapata, 2015; Raja & John, 2010). Together, these findings highlight that both a teacher's creative capacity and the quality of their relationship with school leaders are crucial pathways through which openness to experience leads to innovative teaching practices (Tierney et al., 1999; Zhou & George, 2003). It is worth highlighting that in business administration studies, Schermuly et al. (2013), for example, found no significant direct association between LMX and innovative behaviors. In contrast, Karin et al. (2010) identified a positive and significant relationship between these two factors. These varied results underscore the complex nature of the relationship between LMX and innovation in classrooms, suggesting that the influence of LMX on individual teacher innovation may vary depending on contextual factors and the specific dynamics of teacher-leader relationships.

Our results indicated that, unlike previous research that supported the moderating role of LMX (Smothers, 2023), LMX does not moderate the relation between a teacher's openness to experience and their creativity, nor does it moderate the relation between their creativity and individual teacher innovation in the classroom. Several factors may explain these discrepancies. First, the cultural context of Malaysia, characterized by high power distance and collectivism, may influence the dynamics of LMX differently than in Western contexts. In high power distance cultures, hierarchical relationships often limit open exchanges, which may diminish the moderating effects of LMX on creativity and innovation. This aligns with findings by Rockstuhl et al. (2012), who highlighted cultural differences in LMX dynamics across countries. Second, these results suggest that developing high-quality LMX relationships fosters individual teacher innovation in the classroom, regardless of the teacher's level of creativity (Graen & Uhl-Bien, 1995). This finding aligns with previous studies indicating that while LMX quality is crucial for innovation, it functions independently of individual states such as creativity (Bauer & Erdogan, 2015; Gerstner & Day, 1997). Additionally, we also discovered the average LMX quality is relatively low. Notably, studies by Joo, Yang, and McLean (2014) and Pan, Sun, and Chow (2012) found no significant LMX-creativity relation in Asian contexts, highlighting the contextual nuances of LMX effects. Therefore, while LMX may not moderate the openness-creativity or creativity-innovation links, strengthening LMX could still enhance overall teacher creativity and drive classroom innovation.

5.1. Limitations and suggestions for future research

The results of this research should be considered with attention paid to several limitations. First, the cross-sectional nature of the data precludes offering implications regarding causal relationships and the direction of relations. Future research utilizing longitudinal data is needed to establish a causal relationship. This endeavor would also help address a research gap regarding the sustainability of individual teacher innovation and the extent to which sustainable innovation might be related to school outcomes (Pietsch, Aydin, Montecinos, & Bellibaş, 2025) i.e., achievement, attendance, and completion. Another limitation is related to the scales employed in this research. For instance, we collected data on innovation following the recommendations outlined in the Copenhagen Manual for Collecting Innovation Data in the Public Sector (CO-PI, 2021). While this manual serves as a widely used standard framework, we are aware of only a few studies that have applied it in the context of educational research (i.e. Pietsch et al., 2024; Witthöft et al., 2024). Moreover, the outcome variable, individual teacher innovation, is based on a single item asking teachers to indicate if they implemented innovative teaching practices. This approach is also consistent with the methodology set forth in the Copenhagen Manual for establishing an Innovation Barometer. However, more advanced scales that measure innovative teaching could be used in future

research. Similarly, the creativity scale deals with teachers' perceptions about their creative skills; however, focusing on creative thinking (e.g., if you imagine a better classroom teaching, how does it look like) might help develop a better understanding of the nature and scope of teacher creativity (e.g. Chiu, 2012; Wabeh et al., 2024). Furthermore, it is important to acknowledge that our study is based on self-reported data, which carries the potential risk of bias (Costa & Hauck Filho, 2019). The fundamental assumption underlying the use of self-report scales is that respondents' answers accurately reflect their knowledge or ideas (Baumgartner & Steenkamp, 2001). Consequently, McCall (2013) posits that self-reports are not inherently biased, as individuals perceive their reality as valid and experience real consequences based on those perceptions. Finally, many concepts, including LMX, creativity, and openness to experience, are new to educational research. We recommend that our approach and the study results be validated with other models and methods, as well as that replication studies be conducted in order to provide further evidence of the findings. Since the present research focuses only on a single context, Malaysia, we believe developing an established understanding of the relationship among those variables requires extending the present research to other societies and contexts. In this regard, it is important to ascertain the degree to which the measurement models and relationships between variables can be generalized across cultures, contexts, and time, as well as to identify the factors that moderate these associations (Pietsch et al., 2023). Given the increasing need for schools worldwide to innovate and change continuously, adopting and applying the guidelines and manuals we have used in other contexts could be a valuable first step.

6. Conclusion

The current study has extended the knowledge base in several ways. First, this study examined the relationship between openness to experience, LMX, teacher creativity, and innovative teaching practices within Malaysian schools. Unlike previous studies predominantly conducted within business settings, this research introduces and applies these concepts to explore their impact on innovation in educational settings. Second, this study provided empirical evidence within a centralized education system in a Southeast Asian society, highlighting the relationship between teacher's openness to experience and individual teacher innovation. Third, the research indicated that teacher creativity and LMX are essential in their own right and also act as indirect pathways for the effect of openness to experience on individual teacher innovation. Finally, the study highlights the need for further research, considering the finding that LMX does not moderate the relation between a teacher's openness to experience and their creativity, nor does it moderate the relation between their creativity and individual teacher innovation in the classroom, within a multiple moderated-mediation effects model. These inconsistencies may be attributed to contextual factors, such as cultural differences and organizational environments. For instance, in high power distance cultures like Malaysia, hierarchical structures may influence the dynamics of LMX and creativity differently than in Western contexts (Adams & Periasamy, 2024).

The study has several key implications for educational policy and teacher training, both in the Malaysian context and globally. Similar to other emerging regions, the current educational reform movement in Malaysia aims to elevate its education system to meet international benchmarks such as PISA and TIMSS, fostering teacher creativity and cultivating strong principal-teacher relationships are critical components. This research highlights that teachers' openness to experience enhances their creativity and strengthens relationships with school leaders, driving innovative teaching practices. Policymakers can leverage these insights to develop targeted strategies for improving educational outcomes.

One key recommendation is the implementation of professional development programs that encourage teachers to embrace creativity and adopt innovative teaching methods. Training initiatives focusing on creativity in education can equip teachers with the tools and confidence needed to experiment with new pedagogical approaches that engage students more effectively. Additionally, leadership training for school principals is essential to develop their ability to build high-quality relationships with teachers as principals play a pivotal role in creating supportive environments that foster teacher creativity and innovation.

Our findings emphasize the critical role of leader-teacher relationships in fostering teacher creativity and innovation. High-quality leader-member exchange (LMX) relationships, built on trust, respect, and open communication, enhance teachers' capability to engage in innovative practices. Principals who provide professional development opportunities, recognize creative efforts, and offer support create an environment conducive to innovation. These strong relationships also enables teachers to implement innovative teaching strategies more effectively, thereby contributing to ongoing educational reforms and improved student outcomes.

Comparatively, similar dynamics are observed in other cultural contexts, suggesting a broader applicability of these findings. For instance, a study in China by Bao (2024) and Lin's (2022) analysis within the Teaching and Learning International Survey (TALIS) both emphasize the role of supportive leadership and teacher autonomy in fostering innovation. Likewise, research from Hsieh et al. (2024) in Taiwan highlight how leadership directly enhances teacher innovativeness. This cross-cultural resonance underlines the potential for these findings to inform educational policies and practices globally, not just in Malaysia.

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CRedit authorship contribution statement

Donnie Adams: Writing – review & editing, Writing – original draft, Validation, Project administration, Investigation, Data

curation. **Mehmet Şükürü Bellibaş:** Writing – review & editing, Writing – original draft, Investigation. **Vasu Muniandy:** Writing – review & editing, Validation, Project administration, Data curation. **Marcus Pietsch:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Data availability

Data will be made available on request.

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